SCIENCE.

FRIDAY, OCTOBER 19, 1883.

## PRECISION OF OBSERVATION AS A BRANCH OF INSTRUCTION.

We sometimes find the philosopher envying the physicist because the results sought by the latter can be expressed *exactly*. In so doing, he doubtless overlooks the fact that all quantitative work has to be regarded as giving merely an approximation to the truth. Numerous and refined as are the precautions adopted, the careful experimenter must admit that his measurements contain errors whose sources are more or less hidden. Success will lie, not in ignoring this, but in recognizing it, and studiously avoiding any unwarranted claim to accuracy. His investigation may establish some law beyond a reasonable doubt. This law may be expressible in exact terms; but, so far as the direct quantitative results are concerned, he must give up, once for all, the popular notion of exactness. He must admit that the work merely shows it to be reasonable to assume the truth to lie somewhere between two limits, respectively greater and less than the one magnitude which he names. Desiring that these limits shall fall as near together as practicable, he will study the observations for internal evidence of the precision attained; but any appearance of accuracy greater than might reasonably be expected will often cause him more uneasiness than would a greater apparent error. Until the extent of the error is recognized, and found to be in harmony with experience derived from other similar observations, a cautious observer will not be confident of the result reached.

As the scientific professions are currently taught, it is possible to get a fair training (as a chemist, engineer, or electrician, for example) without properly appreciating the practical limitations to precision. He may instinctively acquire correct notions of the performances of the instruments he most frequently uses; but let a new operation, with a different instrument, be required, and he will too often develop the wildest notions as to the great accuracy attainable by the use of sufficient care. What is needed in our professional courses is systematic instruction in the general science of planning, conducting, and discussing observations, accompanied with adequate practice. This should be given as early as the student is fitted to profit by it, in order that the subsequent practical training in special branches may have a firm foundation.

The field for such instruction is ample. A good routine observer is one who, being informed of the accuracy desired at each step, is able to take just care enough to attain it, without wasting time and energy in uselessly perfecting certain parts of the work. Our professional observer must add to this the good judgment which is able to discover the relative accuracy required in different parts of a complex observation, and to decide how accurate to aim to make a single performance of the whole. In general, he will seek to avoid errors which usually occur in a single direction; but he will not always take the greatest care to avoid errors which are as liable to be negative as positive. Life is short. Time, to most, is money; and the ability to repeat an observation will often depend upon the ability to do it quickly. Moreover, in many cases, mere lapse of time allows additional errors to enter. Having avoided the larger errors, he will therefore seek to eliminate the effect of the smaller by repeatedly performing the work. Recognizing, then, the importance of reasonable speed, he will allow rough measures of certain quantities, provided the final error of the complex operation is not thereby appreciably affected. All this calls for a clear understanding of the causes of error, and an ability to reason out their effect upon the result. The knowledge of the

differential calculus required is indeed elementary; but it must be a *tool* which can be applied as readily, for instance, as the knowledge of the properties of logarithms. All the principles are covered by the customary courses in physics and mathematics; but additional special practice in their employment is very desirable.

In the planning of observations, the theory of maxima and minima gives important aid; but this theory has so many other applications, that we can hardly ask of the regular course in differential calculus such attention to this one point as would insure the required facility. In the absence of such a course of instruction as is recommended in this paper, the matter is left to slow acquisition through practical experience. Knowledge is often thus bought at a high cost.

A general understanding of instruments of precision, so necessary to successful planning of observations, is also within the field of instruction proposed. Instrumental errors should be treated systematically: their preliminary adjustment to zero, their elimination from the mean of pairs of observations properly taken to that end, their determination in such manner that corrections may be duly applied, and the cost in time of variously managing them, should come to be understood through suitable practice. Here, particularly, each professional course is liable to inculcate its own narrow view.

An examination of the proceedings of the leading learned societies will convince one of the importance of good method in the discussion of results. It will also develop the fact that there exist numerous valuable, analytical, and graphical processes, which at present are not likely to be brought to the attention of the professional student.

The theory of probabilities as applied to observation would naturally be treated in the course proposed. If it were previously given to the student as a branch of pure mathematics, the attention could here be riveted upon its use, which calls for the exercise of much practical good judgment. It furnishes an important means of studying the precision attained, but just here is a great abuse. Its results, demonstrated for a very large number, are applied to very limited series of measurements. Again: its assumption of equal probability for equal positive and negative errors is allowed, in face of the fact that a preponderance of error in one direction is unavoidable. The rising generation of experimenters in every field of applied science should therefore be taught the many limitations which surround its application, and they should learn to avoid that indiscriminate use of its principles which has led to so many unfounded claims to accuracy.

We have outlined a subject the successful teaching of which requires qualifications not to be found in every scientific professor, and the successful study of which requires a concentration of the attention not likely to be given to it as a subordinate part of some other course. Already the appearance of treatises on probabilities, errors of observation, and least squares, has enabled writers on astronomy, geodesy, physics, and engineering, to devote their attention to special applications, and has saved the waste of space which would otherwise be given to the general theory. Similarly, we should avoid that distraction of the student's attention from the main subject of a professional course which results from the necessity of frequently pausing to give additional information about the subject of this article.

Although the first object of establishing a course of instruction in any branch of applied science is to put the students into possession of the best methods already reached by workers in that field, the end attained is often something more. The instructor's attention is speedily called to conspicuous omissions, and his energies are consequently bent upon supplying the defect by demonstrating and testing some theorem or method which meets the want. Thus the schools come to the aid of the professions. Are they yet doing their whole duty in regard to the science and art of observation?

## *A SYSTEM OF LOCAL WARNINGS AGAINST TORNADOES.*

I HAVE lately examined with some care the excellent compilation by Sergeant Finley of the signal-service, 'Characteristics of six hundred tornadoes,' with reference to the question of devising a simple apparatus for saving human life.

Saving property seems to be out of the question, as no structure can withstand the force of the tornado-wind. Life may be saved by recourse to underground shelters, cellars, etc., such as actually have been built in many places for this end.

Two facts may be quoted from the work named, — 1°. Three hundred and forty-seven out of three hundred and ninety-three tornadoes (that is eighty-eight per cent) originated between the west and the south-south-west points; 2°. The average velocity of progression was about one mile in two minutes.

From what we already know of the atmospheric conditions necessary to the production of tornadoes, it seems probable that in the future it may be practicable for the general weather service in Washington to send out warnings a day in advance to large regions of country within which tornadoes are likely to occur. These warnings would necessarily be of a very general nature. They would simply state that the conditions were such on two sides of a large region (like the state of Wisconsin, for example) as to make it probable that tornadoes would occur somewhere inside that region within twenty-four hours. The local weather services of states like Ohio and Iowa could, perhaps, make these predictions a little more specific; but there is no prospect whatever that warnings of any particular tornado can be given in the immediate future. It can be said, that, within a district five hundred miles square, tornadoes are likely to occur within twenty-four hours, and such a warning would be of value; but it does not seem to be probable that it can be said that a particular thirty miles square of this region is in particular danger. Under these circumstances, it is of interest and importance to inquire whether some efficient method of local warnings cannot be devised. If five minutes' warning could have been given at any of the late tornadoes, many lives might have been saved. If each household could be warned by the continuous ringing of a bell, for example, that a wind of destructive force (say, seventy miles per hour and upwards) was approaching, and that five minutes were available in which to seek shelter, this would be well worth doing.

A wind of seventy miles an hour is sufficient to blow down chimneys and to unroof houses, unless they are well built. Ordinary trees will not stand under it. The pressure on a square foot is in the neighborhood of fifty pounds. There might be occasions where seventy miles would be the maximum wind-velocity; and the person who had taken refuge in the cellar might be inclined, after the gust had blown over, to find fault with the indicator which had predicted a tornado, when only a violent gale occurred. But such storms do not occur as often as once a year; and it would seem that one could afford to be frightened as frequently as this for the sake of immunity from an occasional tornado, which might be following in the track of such a violent gale.

I have found that it is practicable to erect, at a moderate expense (less than five hundred dollars), an apparatus which would give from three to five minutes' warning to all the inhabitants of a small town, by the firing of a cannon, for instance; and in addition, and without any increased expense, this apparatus could ring a bell in every house. The additional expense to each house would be less than ten dollars, the cost of maintenance would be less than a hundred dollars a year, and the work could be done by any intelligent person. The system, for a small town, would be something like the following: suppose a circle described about the town with a radius of from two to two and one-half miles. The only serious danger from tornadoes is to be feared from the part of this circle between the west point and the south-south-west point. Along the circumference of this circle, between the south-south-west and west points, run a line of single telegraph-wire on twenty posts to the mile, and from the west point bring the wire into the town, letting it end at the telegraph-office. It is grounded at each end of the line, and at the telegraph-office it is connected with a battery, which sends a constant current over the line. Within the town, connection is made in various houses with magnets. Each magnet holds a detent, which prevents a bell from being rung by the action of a cheap clock-work governed by a coiled spring. If the circuit is broken anywhere in the line, each bell begins to ring, and continues to sound till its spring is run down; for four or five minutes, for example. A cannon could be fired by a simple device, which would warn persons in the fields, etc., to seek shelter. In a large town the circuit might end in one of the engine-houses

of the fire-department, and ring a bell there. This would be the signal for the man on watch to repeat the warnings simultaneously through as many local circuits as desirable.

It remains to indicate the way in which the circuit is to be broken by the wind. The circle of telegraph-poles from the south-south-west to the west points would contain about fifty poles. On every one of these the wire would run first to an insulator, then to an iron horizontal axis screwed into the side of the post. On this axis a piece of board one foot square can revolve freely. An iron rod projects below this board, and from the lower end of it a small wire goes to a pin in the telegraph-pole. This pin is connected by wire to a second insulator. From this the line goes to the next pole, and so on. The circuit ordinarily passes to the first insulator, thence to the iron rod, thence down the iron rod to the thin wire, through the pin and to the second insulator, and so to the next telegraph-pole. The thin wire is a necessary part of the circuit. It is so made that it will break when the pressure of the wind on the square board is fifty pounds. The apparatus for each post is tested practically before it is set up. This can be done at any time in a simple manner. Whenever any single one of these boards is subjected to the pressure of fifty pounds, its wire will be ruptured, and the circuit will be broken, thus sending the necessary warning along the whole line.

I have made one such indicator, which is connected with a small bell in this observatory. The wire is arranged so that it breaks at a wind-velocity of about ten miles per hour, and it works in a perfectly successful manner. The extension of the system for the protection of a small town is a simple matter. For a large city a more expensive system would have to be provided, as the wires between poles should be carried underground to protect them from the chance of disturbance.

I need not enlarge on the details of the scheme, since they can be worked out by any one who is at all familiar with electrical constructions. I believe that I have considered all the practical difficulties, and that there are none of any importance. It is a very simple matter to provide for the inspection of the line, bells, etc., so as not to interfere with the working of the system, and so that false alarms will not be given.

The point I wish to emphasize is, that a practical and cheap system of local warnings can be had, and that it ought to be considered by those who live in districts subject to tornadoes. The particular manner in which the above-described device is to be employed is a question to be settled by the particular circumstances of each case. I have only described the simplest and cheapest form, but this has been proved by trial to be efficient.

I may just mention, that, by employing a spring balance to hold the board in position, it is possible to provide an indicator which will break the circuit at any desired velocity of wind.

To any one who has seen the effects of a tornado, or even to one who has simply read that in this year alone several hundreds of lives have been lost from their violence, it will appear that the question of erecting systems for local warnings ought to be seriously considered by persons living in exposed regions.

EDWARD S. HOLDEN.

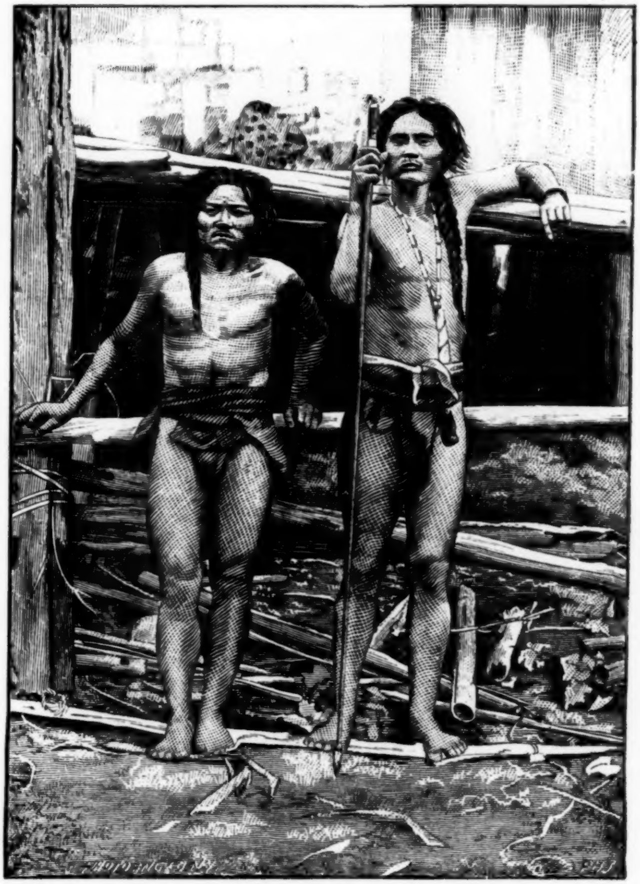
## THE WILD TRIBES OF LUZON.

WHEN the Malays took possession of the Philippines, they either found there, or were soon joined by, Japanese, Chinese, Siamese, Javanese, and Dyaks from Borneo and Celebes, all waging war against the Papuans, who had gone there from the south-east, if they were not aborigines. Under these circumstances, we should expect to find the present natives a very mixed race, who have received different names, according to the predominating characters in each locality. There is no unanimity of opinion among those who have studied the people in their own homes, and I think it impossible wholly to unravel the tangled skein of races. The following is what, from my observation and reading, I think a fair approximation to the truth.

The name of *Igorrote* has been applied to almost every wild tribe except the Negritos. I agree with Dr. Semper that it should be restricted to those of northern Luzon, who are hybrids of Japanese and Chinese with the Indians, differing somewhat in features and customs, according to the principal admixture.

In the Igorrote the stature is small, with well-developed form, indicating great strength with little symmetry; color very dark; eyes oblique; hair long, and, in the women, combed in Chinese fashion; nose flat, lips thick, mouth large, and cheeks wide. Houses mere huts, on the ground or raised on posts, shaped like a beehive, with furniture of the rudest description, — arms, hatchets, lances, daggers, bows and arrows, frequently poisoned, of bamboo, and shields. Their presence would be accounted for as the descendants of the army of

the Chinese pirate, Li Mahon, whose fleet was destroyed after his attack on Manila in 1574. The fugitives escaped to the mountains; and for more than three centuries these wild hybrids between Chinese and Indian have defied the power of Spain. They have many dialects, but the Igorrote proper is spoken by over ten habit northern Ilocos. They are of finer shape, lighter color, with less oblique eyes, and more aquiline nose. In their habits, music, and love for porcelain vases, they resemble the Japanese, and have probably descended from the union of crews of junks, driven to Luzon by the northern monsoon, and the neighboring tribes.



IGORROTES OF LUZON.

thousand people. They are not wholly savage, except in the remote mountainous districts. Their customs are simple and patriarchal. It is only of late years that they have consented to bury their dead, instead of exposing them to decay in the air.

The name of *Tinguians* has been given to the hybrids of Japanese and Indians who in-

They number over nine thousand in twenty villages. Their dress and arms are much like those of the Igorrotes, but they have borrowed from their enemies the Gaddans the custom of preserving as trophies the heads of those killed in battle. They are said to mummify their dead by heat.

The *Gaddans* and *Ifuagos*, numbering about

ten thousand, resemble in their appearance and customs the Dyaks of Borneo. Many dwell in the provinces of the Camarines, where they have preserved their independence. They have traditions of great antiquity, and speak the Vicol dialect as well as their own. They were evidently here before the Mahometan Malays, by whom they have been driven to the mountains. They are hostile to all foreigners. Their mode of life is patriarchal, the head of a family recognizing no superior authority. From the resemblance of the skulls of some of these wild tribes to those of the people of Sunda, Borneo, and Celebes, and the occurrence of similar ones in the long disused caverns, it seems undeniable that there is among them a considerable Dyak mixture, and that from a very remote period.

The above-mentioned races are what the Spanish writers call the *infidels*, and may or may not be Igorrotes. Samuel Kneeland.

GADDAN OF LUZON.

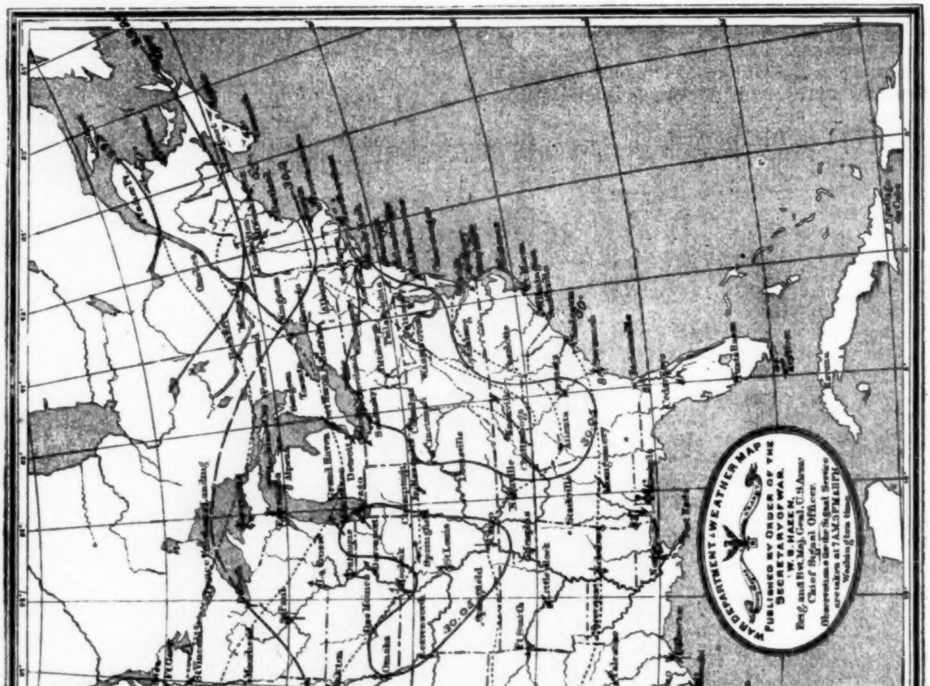
## *THE WEATHER IN AUGUST, 1883.*

The monthly review of the U. S. signal-service shows that in August there were two features of special note. These are, 1°, the low temperatures which prevailed over nearly the whole country; 2°, the small rainfall, which was below the average in nearly every district. Other important features were a few destructive storms, and the opening of the hurricane season, as will be referred to below.

The pressure has been above the normal, except on the Atlantic coast; the greatest excess, 0.08 inch, occurring in the upper Mis-

sissippi and Missouri valleys, where, also, the lowest temperature departures were recorded. Six barometric depressions were charted in their progress, and a seventh begun, as the month closed. Of these, one only visited the southern states: this developed in Mississippi, passed off the Virginia coast, and across the Atlantic to the Irish coast, being a severe storm all along its passage. Of the other depressions, one developed in the Rocky Mountains, and was traced to the British coast, and another entered the country in the extreme south-west, moved south-easterly to the North Carolina coast, and in the ocean probably united with a tropical hurricane which was then moving up the Atlantic. None of the storms were traced from the Pacific coast over the Rocky Mountains. The storms left no disastrous effects in the United States; but there were violent gales on the upper lakes on the 22d, and remarkably heavy rains on the North Carolina coast on the 16th. The storms on the Atlantic were especially prominent, and the general character of the weather on the ocean during the whole month was stormy. Five depressions were traced nearly across the Atlantic, two of which were genuine hurricanes. The first moved north-westward at a considerable distance from the Atlantic coast, between the 19th and 24th, when it curved to the north-eastward near the Bermudas. Reaching the Banks on the 26th, it caused great damage to the fishing-fleet, the reports showing a loss of eighty lives and one hundred dories, while many fishing-vessels were swamped or disabled. Vessels on the Atlantic report severe gales during its further passage, but its severity decreased as it approached the Irish coast on the 29th. The lowest pressure

GADDAN WOMAN.



MONTHLY MEAN ISOBARS, ISOTHERMS, AND WIND-DIRECTIONS, AUGUST, 1883. REPRINTED IN REDUCED FORM BY PERMISSION OF THE CHIEF SIGNAL-OFFICER.

noted was 28.9 inches. The second hurricane came from the West Indies about the 24th, and reached the Banks on the 29th, only three days after the passage of the former hurricane, repeating the disasters to the fishing-vessels. Its violence was great as it continued across the Atlantic, and approached the British coasts early in September. As this storm passed up the Atlantic, very high tides were experienced on the coast, much damage being thereby inflicted on the New Jersey shore on the 29th. Very few icebergs were reported during the month.

The average temperatures were above the normal only in Florida, the Rio Grande valley, and in the middle and southern portions of the Rocky Mountain region, the departures being within a degree, except at Salt Lake City (2°). In other districts the departures ranged from 0°.1, in the eastern Gulf states, to 4°.4, in the upper Mississippi valley. Yuma, Arizona, reports a mean temperature of 91°, and a maximum of 111°. Frosts were reported from the northern states, especially at the end of the month.

*Average precipitation for August, 1883.*

| Districts. | Average for August. Signal-service observations. | | Comparison of August, 1883, with the average for several years. |
|---|---|---|---|
| | For several years. | For 1883. | |
| | Inches. | Inches. | Inches. |
| New England . . . . | 4.33 | 1.53 | 2.80 deficiency. |
| Middle Atlantic states . | 4.95 | 3.20 | 1.75 deficiency. |
| South Atlantic states . . | 6.43 | 7.51 | 0.72 deficiency. |
| Florida peninsula . . . | 7.67 | 5.69 | 1.98 deficiency. |
| Eastern gulf . . . . . | 6.33 | 4.39 | 1.94 deficiency. |
| Western gulf . . . . . | 4.27 | 1.62 | 2.65 deficiency. |
| Tennessee . . . . . . | 3.92 | 3.51 | 0.41 deficiency. |
| Ohio valley . . . . . | 3.70 | 1.94 | 1.76 deficiency. |
| Lower lakes . . . . . | 2.91 | 2.30 | 0.61 deficiency. |
| Upper lakes . . . . . | 3.12 | 1.25 | 1.87 deficiency. |
| Extreme north-west . . | 2.50 | 2.70 | 0.20 excess. |
| Upper Mississippi valley, | 3.40 | 1.87 | 1.53 deficiency. |
| Missouri valley . . . . | 2 81 | 2.52 | 0.29 deficiency. |
| Northern slope . . . . | 1.39 | 1.83 | 0.44 excess. |
| Middle slope . . . . . | 1.42 | 3.65 | 2.23 excess. |
| Southern slope . . . . | 2.99 | 1 95 | 1.04 deficiency. |
| Southern plateau . . . | 3.16 | 2.26 | 0.90 deficiency. |
| North Pacific coast. . . | 0.78 | 0.08 | 0.70 deficiency. |
| Middle Pacific coast . . | 0.02 | 0.00 | 0.02 deficiency. |
| South Pacific coast . . . | 0.22 | 0.07 | 0.15 deficiency. |
| Mt. Washington, N.H. . | 7.67 | 6.06 | 1.61 deficiency. |
| Pike's Peak, Col. . . . | 4.81 | 2.22 | 2.59 deficiency. |
| Salt Lake City, Utah . . | 0.88 | 0.62 | 0.26 deficiency. |
| Brownsville, Tex. . . . | 5.94 | 1.97 | 3.97 deficiency. |

The rainfall record can be best shown by the above table, which shows the unusual deficiency of the month in almost every section, which especially affected the crops in the south. Remarkably heavy rains were recorded in a few instances, — 10.38 inches at Griffin, Ga., in eight hours; and 8.14 inches at Kittyhawk, N.C., in four hours. In the cotton region the rainfall was much less than in August of last year, the amount at New Orleans being 2.70 inches, against 8.38 inches a year ago.

Local storms were not numerous, but were quite severe, especially in Iowa, on the 7th and 8th. On the 21st there was a veritable tornado in Minnesota, which devastated the town of Rochester, causing a loss of over thirty lives, and much damage to property.

Seven auroral displays occurred, but none were of especial note. The following electrical phenomenon is reported from Pike's Peak: —

"The observer on the summit of Pike's Peak, Col., reported that during a sleet and thunder storm, on the evening of the 4th, the anemometer cups revolved in circles of electric light. After a flash of lightning, the light encircling the cups became dim, but would soon regain its former brilliancy. The observer states, that, by holding up his hands, electric sparks would form on the ends of his fingers, and that his hair and clothing were full of them. A peculiar crackling noise was heard about the anemometer cups; and at the corners of the office building there were continuous sparks of bright light."

Earthquake-shocks occurred at Oakland, Cal., Carson City, Nev., St. Thomas, W.I. At the last-named place a tidal wave occurred on the 27th, and at San Francisco on the 27th and 28th. Earthquake waves, whose height was one foot, and time between crests forty minutes, were recorded on the Saucelito tide-gauge. It is supposed they were caused by the earthquake in Java on the 27th.

A dense smoke, due to forest-fires in Oregon and Washington, Idaho and Montana territories, prevailed during a greater part of the month, and extended on the Pacific coast as far south as Cape Mendocino, and thence eastward to eastern Montana, Dakota, and Minnesota.

The accompanying chart exhibits the mean pressure, temperature, and wind-direction, for the month.

## *THE INVENTION AND SPREAD OF BRONZE.*

AT the thirteenth session of the German anthropological congress, held at Trier early in August, Professor Rudolph Virchow, the president, gave an address, the substance of which we quote from the *Frankfurter zeitung* of Aug. 11.

In beginning the president remarked, that, in the choice of Trier as the place of assembly for this year's congress, it was considered that the city and its surroundings were especially suited by their situation for the solution of the often-broached question of celts. The speaker then reviewed in a general

way the present condition of anthropological research, paying especial attention to the first appearance of bronze in Europe. The question, when did the metal first come into use in our part of the world, is certainly one of the most important which anthropological science has to consider, and in order to provide the necessary material for its solution, wherever individual investigators or scientific societies are active, the territorial relations should be first examined, and, without drawing general conclusions, the localities or the strata in which the discoveries are made should be determined; for, however many investigations have already been undertaken in this branch of anthropology, the boundary where the stone age ceases and the metal age begins has not yet been definitely decided for any locality. A difficulty which arises in answering the question, does this or that settlement, this or that discovery, belong to the stone or bronze age, must not be passed in silence, since neglect of it has frequently led to mistakes. The difficulty is, that at one time, when metal was already common, stone implements were used both by poorer people, who were not able to obtain the expensive tools, and for ritualistic purposes. A circumstance which next comes into consideration, and which renders difficult in no little degree the determination of the epoch to which certain discoveries belong, is that the river-sand, silt, etc., in which the objects were found, often change their positions.

Passing to a general consideration of the bronze age, the speaker said that the answer to the question, where did the invention of this alloy originate, is one of the most important problems for anthropological research. There are two widely differing views on this subject: 1°, that of investigators who assume that bronze was invented at different times and in different places, independently of each other; and, 2°, that of those who assert that the invention was made at one place, and thence the use of the metal spread. In opposition to the first-mentioned assumption, is the fact that the bronze objects scattered over many regions show in their composition a considerable agreement, and, almost without exception, are composed of a mixture of nine parts copper and one part tin, as are by far the majority of those which are found in the countries lying between the Caucasus and Portugal. Even if the moisture of the earth and atmospheric influences affect the various components of the alloy in various ways, and a part of the copper is destroyed or altered, the bronze objects, as a whole, are affected in the same way; and the appearance of a very similar composition, in regions far removed from each other, points with convincing force to the conclusion that the invention of this mixture was made in one place, and its use was thence spread. Further, as to how bronze was introduced into Europe, we find also various opinions not very harmonious with each other. Some investigators naturally claim that it was through the Phoenicians, of whom we know that in ancient time they carried on a trade extending over the whole Mediterranean, and that while Cyprus, one of the chief centres for copper ore, — from this island copper (Latin, *cuprum*) received its name, — lay in their immediate neighborhood, they passed in their voyages the Pillars of Hercules, and visited the 'tin-island' (Great Britain). From the Phoenician trade-stations on the coast of the Mediterranean, among which the Massilian colony (Marseilles) played an important part, trade-roads into the interior were probably built. Many investigators suppose the spread of bronze was through commercial activity. Whether this view is true, is not easy to determine; since trade-settlements, which, as a rule, exert no, or at most only a transient, influence over the majority of the colonies and customs with which they come in contact, as soon as they cease to exist, can seldom be traced. The speaker, in his researches in Sicily, where, as is well known, the Carthaginians, also a people of Phoenician origin, were for a long time settled, could find no traces which indicated this settlement. Further, it is also well known that the trade supremacy which Pisa on the Mediterranean, and Genoa on the Black Sea, once exercised, has left on the coasts bordering these seas no traces worth mentioning. But, supposing that bronze was scattered by the commerce of the Phoenicians, it by no means proves that they were the inventors of this alloy. The speaker, on the whole, was much more inclined, with reservation of his decision, to place this invention farther to the east, in central Asia.

Besides the view just mentioned, which considers the commercial activity of the Phoenicians as the agent by which that advance in culture signalized by the use of metal implements was brought about, there is a theory lately advanced by Hochstetter, which deserves mention because it completely abandons the views formerly held. Hochstetter bases his assumptions on the discoveries in the graves at Hallstadt (first described by Sacken), and on certain discoveries at Watsch (Carniola), which show an interesting similarity to the former.[1] From these data, Hochstetter traces the identity of bronze manufacture in Hallstadt and upper Italy, and comes to the conclusion that this manufacture originated with the Aryans, and that the use of bronze for weapons and vessels had been common among this people a long time before the Aryan races wandered from their Asiatic home to Europe; while, at the same time, he denies the Etruscan origin of the findings at Hallstadt, Watsch, and Este, and assumes that the bronzes found in Italy, so far as they were not brought there by the Aryans inhabiting Italy, were imported from Greece.

Against these conclusions, surprising by their novelty, Virchow asserts, that in case the Aryans, in their wanderings to the west, had taken bronze with them, we must expect to find traces of its use on the highways, which they presumably followed in their

[1] A situla dug up at Watsch exhibits the same decoration as those found at Hallstadt, and contains, among other things, a representation of warriors, who are equipped with four different kinds of helmets, such as may be reconstructed from the discoveries at Hallstadt. Objects corresponding to the Watsch bronzes were found also in Este (North Italy).

advance ; for example, in the valley of the Donau. Especially in regard to the Caucasus, his investigations in the region convinced him that no people already sufficiently civilized to employ metals could have passed over this range; and, on account of the geographical relations, we must assume that the Aryan peoples first divided in central Asia, and separated widely along the northern coast of the Aral and Caspian seas, and then proceeded through modern Russia, where the characteristic bronzes are not found, or westward through Asia Minor. Once in Greece, it is highly probable that Italy was their next step. A fact brought forward by Hochstetter in support of his theory — viz., the lack of ribbed bronzes, Mestea dicordoni — has proved a mistake. A point of attack is presented by the same investigator, in his assertion that the discoveries at Hallstadt do not date back of the second millenary before the Christian era, and immediately preceded the Roman civilization; and that, at the time of the subjugation of Noricum by Rome, the manufacture of bronze already existed.

At the close of his address, Virchow merely touched upon other anthropological questions, and pointed out that philology and archeology alone were not in condition to relieve the darkness which still concealed the invention and spread of bronze; and that somatic anthropology, i.e., the investigation of the physical constitution of the peoples under consideration, as seen from the bones preserved to us, may here have a final word to say, and may, perhaps, answer the important question, whether the cultivation of central Europe is to be traced to the influence of two different families, or to only one, the Aryan.

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## *THE VEGETATION OF THE CARBONIFEROUS AGE.*[1]

Much of the second decade of my life was spent in the practical pursuit of geology in the field ; and throughout most of that period I enjoyed almost daily intercourse with William Smith, the father of English geology. But, in later years, circumstances restricted my studies to the paleontological side of the science : hence I was anxious that the council of the British association should place in this chair some one more familiar than myself with the later developments of geographical geology. But my friend, Professor Bonney, failing to recognize the force of my objections, intimated to me that I might render some service to the association by placing before you a sketch of the present state of our knowledge of the vegetation of the carboniferous age.

This being a subject respecting which I have formed some definite opinions, I am going to act upon the suggestion. To some this may savor of 'shop-talk;' but such is often the only talk which a man can indulge in intelligently: and to close his mouth on his special themes may compel him either to talk nonsense or to be silent.

Whilst undertaking this task, I am alive to the difficulties which surround it, especially those arising from the wide differences of opinion amongst paleobotanists on some fundamental points. On some of the most important of these there is a substantial agreement between the English and German paleontologists. The dissentients are chiefly, though not entirely, to be found amongst those of France, who have, in my humble opinion, been unduly influenced by what is in itself a noble motive ; viz., a strong reverence for the views of their illustrious teacher, the late Adolphe Brongniart. Such a tendency speaks well for their hearts; though it may, in these days of rapid scientific progress, seriously mislead their heads. I shall, however, endeavor to put before you faithfully the views entertained by my distinguished French friends, M. Renault, M. Grand-Eury, and the Marquis of Saporta, giving, at the same time, what I deem to be good reasons for not agreeing with them. I believe that many of our disagreements arise from geological differences between the French carboniferous strata and those in our own islands. There are some important types of carboniferous plants that appear to be much better represented amongst us than in France: hence we have, I believe, more abundant material than the French paleontologists possess, for arriving at sound conclusions respecting these plants. We have rich sources, supplying specimens in which the internal organization is preserved, in eastern Lancashire and western Yorkshire, Arran, Burntisland, and other scattered localities: France has equally rich localities at Autun and at St. Étienne. But some important difference exists between these localities. The French objects are preserved in an impracticable siliceous matrix, extremely troublesome to work, except in specimens of small size: ours, on the other hand, are chiefly embedded in a calcareous material, which, whilst it preserves the objects in an exquisite manner, does not prevent our dissecting examples of considerable magnitude. But, besides this, we are much richer in huge Lepidodendroid and Sigillarian trees, with their Stigmarian roots, than the French are : hence we have a vast mass of material illustrating the history of these types of vegetation, in which they seem to be seriously deficient. This fact alone appears to me sufficient to account for many of the wide differences of opinion that exist between us, respecting these trees. My second difficulty springs out of the imperfect state of our knowledge of the subject. One prominent cause of this imperfection lies in the state in which our specimens are found. They are not only too frequently fragmentary, but most of those fragments only present the external forms of the objects. Now, mere external forms of fossil plants are somewhat like similarities of sound in the comparative study of languages: they are too often unsafe guides. On the other hand, microscopic internal organizations in the former subjects are like grammatical indentities in the latter one: they indicate deep affinities that promise to guide the student safely to philosophical

[1] Opening address before the section of geology of the British association for the advancement of science. By Prof. W. C. Williamson, LL.D., F.R.S., president of the section. From advance sheets kindly furnished by the editor of *Nature*.

conclusions. But the common state in which our fossil plants are preserved presents a source of error that is positive as well as negative. Most of those from our coal-measures consist of inorganic shale, sandstone, or ironstone, invested by a very thin layer of structureless coal. The surface of the inorganic substance is moulded into some special form, dependent upon structural peculiarities of the living plants; which structures were sometimes external, sometimes internal, and sometimes intermediate ones. Upon this inorganic cast we find the thin film of structureless coal, which, though of organic origin, is practically as inorganic as the clay or sandstone which it invests; but its surface displays specific sculpturings, which are apt to be regarded as always representing the outermost surface of the plant when living, whereas this is not always the case. That the coaly film is a relic of the carbonaceous substance of the living plant is unquestionable; but the thinnest of these films are often the sole remaining representatives of structures that must originally have been many inches, and in some instances even many feet, in thickness. In such cases most of the organic material has been dissipated, and what little remains has often been consolidated in such a way that it is merely moulded upon the sculptured inorganic substance which it covers, and hence affords no information respecting the exterior of the fossil when a living organism. It is, in my opinion, from specimens like these, that the smooth bark of the Calamite has been credited with a fluted surface, and the Trigonocarpons with a merely triangular exterior and a misleading name, as it long caused the inorganic casts known as Sternbergiae to be deemed a strange form of plant, that had no representative amongst living types. In other cases the outermost surface of the bark is brought into close contact with the surface of the vascular cylinder. I have a Stigmaria in which the bases of the rootlets appear to be planted directly upon that cylinder, the whole of the thick intermediate bark having disappeared. In other examples, that vascular zone has also gone. Thus the innermost and outermost surfaces of a cylinder, originally many inches apart, are, through the disappearance of the intermediate structures, brought into close approximation. In such cases, leaves and other external appendages appear to spring directly from what is merely an inorganic cast of the interior of the pith. I believe that many of our Calamites are in this condition. Such examples have suggested the erroneous idea that the characteristic longitudinal flutings belong to the exterior of the bark.

*Fungi.* — Entering upon a more detailed review of our knowledge of the carboniferous plants, and commencing at the bottom of the scale, we come to the lowly group of the fungi, which are unquestionably represented by the Peronosporites antiquarius[1] of Worthington Smith. There seems little reason for doubting that this is one of the phycomycetous fungi, possibly somewhat allied to the Saprolegnieae; but since we have, as yet, no evidence respecting its fructification, these closer relationships must for the present remain undetermined. So far as I know, this is the only fungus satisfactorily proved to exist in the carboniferous rocks, unless the Excipulites Neesii of Goeppert, and one or two allied forms, belong to the fungoid group. The Polyporites Bowmanni is unquestionably a scale of a holoptychian fish.

*Algae.* — Numerous objects supposed to belong to this family have been discovered in much older rocks than carboniferous ones. The subject is a thorny one. That marine plants of some kind must have existed simultaneously with the molluscous and other plant-eating animals of paleozoic times, is obviously indisputable; but what those plants were is another question. The widest differences of opinion exist in reference to many of them. A considerable number of those recognized by Schimper, Saporta, and other paleobotanists, are declared by Nathorst to be merely inorganic tracks of marine animals; and, in the case of many of these, I have little doubt that the Swedish geologist is right. Others have been shown to be imperfectly preserved fragments of plants of much higher organization than algae, branches of conifers even being included amongst them. I have, as yet, seen none of carboniferous age that could be indisputably identified with the family of algae, though there are many that look like and may probably be such. The microscope alone can settle this question, though even this instrument fails to secure unity of opinion in the case of Dawson's Prototaxites; and no other of the supposed seaweeds hitherto discovered have been sufficiently well preserved to bear the microscopic test: hence I think that their existence in carboniferous rocks can only be regarded as an unproven probability. Mere superficial resemblances do not satisfy the severe demands of modern science, and probabilities are an insufficient foundation upon which to build evolutionary theories.

Seeing what extremely delicate cell-structures *are* preserved in the carboniferous beds, it cannot appear other than strange that the few imperfect fungoid relics just referred to constitute the only terrestrial cellular cryptogams that have been discovered in the carboniferous strata. The Darwinian doctrine would suggest that these lower forms of plant-life ought to have abounded in that primeval age; and that they were capable of being preserved is proved by the numerous specimens met with in tertiary deposits. Why we do not find such in the paleozoic beds is still an unsolved problem.

*Vascular cryptogams.* — The vascular cryptogams, next to be considered, burst upon us almost suddenly, and in rich profusion, during the Devonian age. They are equally silent in the Devonian and carboniferous strata as to their ancestral descent.

*Ferns.* — The older taxonomic literature of paleozoic fern-life is, with few exceptions, of little scientific value. Hooker and others have uttered in vain wise protests against the system that has been pursued. Small fragments have had generic and specific names assigned to them, with supreme indifference to the study of morphological variability amongst living types. The undifferentiated tip of a terminal

[1] Memoir xl. p. 299.

pinnule has had its special name, whilst the more developed structures forming the lower part of a frond have supplied two o three more species. Then the distinct forms of the fertile fronds may have furnished additional ones, whilst a further cause of confusion is seen in the wide difference existing between a young, half-developed seedling and the same plant at an advanced stage of its growth. Any one who has watched the development of a young Polypodium aureum can appreciate this difference. Yet, in the early stages of paleontological research, observers could scarcely have acted otherwise than as they did, in assigning names to these fragments, if only for temporary working purposes. Our error lies in misunderstanding the true value of such names. At present the study of fossil ferns is affording some promise of a newer and healthier condition. We are slowly learning a little about the fructification of some species, and the internal organization of others. Facts of these kinds, cautiously interpreted, are surer guides than mere external contours. Unfortunately, such facts are, as yet, but few in number; and, when we have them, we are too often unable to identify our detached sporangia, stems, and petioles, with the fronds of the plants to which they primarily belonged.

That all the carboniferous plants included in the genera Pecopteris, Neuropteris, and Sphenopteris, are ferns, appears to be most probable; but what the true affinities of the objects included in these ill-defined genera may be, is very doubtful. Here and there we obtain glimpses of a more definite kind. That the Devonian Palaeopteris hibernica is an hymenophyllous form appears to be almost certain; and, on corresponding grounds, we may conclude that the carboniferous forms, Sphenopteris trichomanoides, S. Humboldtii,[1] and Hymenophyllum Weissii,[2] belong to the same group. The fructification of the two latter leaves little room for doubting their position, whilst the foliage of some other species of Sphenopteris is suggestive of similar conclusions; but, until their fructification is discovered, this cannot be determined. An elegant form of Sphenopteris (S. tenella, Brong.; S. lanceolata of Gutbier), recently described by Mr. Kidson of Stirling, abundantly justifies caution in dealing with these Sphenopterides. This plant possesses a true sphenopteroid foliage, but its fructification is that of a marattiaceous danaid. The sporangia are elongated vertically, and have the round terminal aperture of both the recent and fossil Danaiae, — a group of plants far removed from the hymenophyllaceous type of sphenopterid already referred to.

Whether or not this Sphenopteris was really marattiaceous in other features than in its fructification, is uncertain; but I think that we have indisputably got stems and petioles of Marattiaceae from the carboniferous strata. My friend M. Renault, and I, without being aware of the fact, simultaneously studied the Medullosa elegans of Colta. This plant was long regarded as the stem of a true monocotyledon, — a decision the accuracy of which was doubted first by Brongniart, and afterwards by Binney. M. Renault's

[1] Schimper, vol. i. p. 408. [2] *Ibid.*, p. 415.

memoir, and my part vii., appeared almost simultaneously. We then found that we had alike determined the supposed monocotyledon to be not only a fern, but to belong to the peculiarly aberrant group of the Marattiaceae. As yet we know nothing of its foliage and fructification.

M. Grand-Eury has figured[1] a remarkable series of ferns from the coal-measures of the basin of the Loire, the sporangia of which exhibit marked resemblances to those of the Marattiaceae. This is especially the case with his specimens of Asterotheca and Scolecopteris,[2] as also with his Pecopteris Marattiaetheca, P. Angiotheca, and P. Danaeaetheca; but there is some doubt as to the dehiscence of the sporangia of these plants: hence their marattiaceous character is not absolutely established.

That the coal-measures contain the remains of arborescent ferns has long been known, especially from their abundance at Autun. In Lancashire I have only met with the stems or petioles of one species preserving their internal organization.[3] The Rev. H. H. Higgins obtained stems that appear to have been tree-ferns from Ravenhead, in Lancashire; and it is probable that most of the plants included in the genera Psaronius, Caulopteris, and Protopteris, are also tree-ferns.

There yet remains another remarkable group of ferns, the sporangia of which are known to us through the researches of M. Renault. In these the fertile pinnules are more or less completely transmuted into small clusters of oblong sporangia. In one case, M. Renault believes that he has identified these organs with a stem or petiole of a type not uncommon at Oldham and Halifax, belonging to Corda's genus Zygopteris. Renault has combined this with some others to constitute his group of Botryopteridées, an altogether extinct and generalized type. This review shows, that whilst forms identifiable with the Hymenophyllaceae and Marattiaceae existed in the carboniferous epoch, and we find here and there traces of affinities with some other more recent types, most of the carboniferous ferns are generalized primeval forms, which only become differentiated into later ones in the slow progress of time.

*Equisetaceae and Asterophylliteae* (*Brongniart*), *Calamariae* (*Endlicher*), *Equisetineae* (*Schimper*). — Confusion culminates in the history of this variously named group: hence the subject is a most difficult one to treat in a concise way. The confusion began when Brongniart separated the plants contained in the group into two divisions, one of which (Équisétacés) he identified with the living equisetums, and the other (Astérophyllitées) he regarded as being gymnospermous dicotyledons. To Schimper belongs the merit, as I believe it to be, of steadily resisting this division; nevertheless, paleobotanists are still

[1] Flore carbonifère du Départment de la Loire et du centre de la France.

[2] *Loc. cit.*, tab. viii., figs. 1-5.

[3] Psaronius Renaultii, Memoir vii., p. 10; and Memoir xii., pl. iv., fig. 16. These and other similar references are to my series of memoirs on the organization of the fossil plants of the coal-measures, published in the Philosophical transactions.

separated into two schools on the subject. Dawson, Renault, Grand-Eury, and Saporta adhere to the Brongniartian idea; whilst the British and German paleontologists have always adopted the opposite view, rejecting the idea that any of these plants were other than cryptogams.

A fundamental feature of the entire group is in the fact that their foliar appendages, however morphologically and physiologically modified, are arranged in nodal verticils. This appears to be the only characteristic which the plants possess in common.

*Calamites and Calamodendron.*— In his 'Prodrome' (1828), and in his later 'Végétaux fossiles,' Brongniart adopted the former of these generic names as previously employed by Suckow, Schlotheim, Sternberg, and Artis. It was only in his 'Tableau des genres de végétaux fossiles' (Dictionnaire universel d'histoire naturelle, 1849) that he divided the genus, introducing the second name to represent what he believed to be the gymnospermous division of the group. A long series of investigations, extending over many years, has convinced me that no such gymnospermous type exists.[1] The same conclusion has more recently been arrived at by Vom c. M. D. Stur,[2] after studying many continental examples in which structure is preserved. What I regard as *an* error appears to have had an intelligible origin, — the fertile source of similar errors in other groups.

Nearly all the Calamitean fossils found in shales and sandstones consist of an inorganic, superficially fluted substance, coated over with a thin film of structureless coal (see 'Histoire des végétaux fossiles,' vol. i. pl. 22); *the latter being exactly moulded upon and following the outlines of the inorganic fluted cast that underlies it.* Brongniart, and those who adopt his views, believe that the external surface of this coal-film exactly represents the corresponding external surface of the original plant: hence the conclusion was arrived at, that the plant had a very large central fistular cavity, surrounded by a very thin layer of cellular and vascular tissues, as in some living equisetums. On the other hand, Brongniart also obtained some specimens of what he primarily believed to be Calamites, in which the central pith was surrounded by a thick layer of woody tissue arranged in radiating laminated wedges, separated by medullary rays. The exogenous structure of this woody zone was too obvious to escape his practised eye. But, not supposing it possible that any cryptogam could possess a cambium-layer and an exogenous mode of development, Brongniart came to the conclusion that the thin-walled specimens found in the shales and sandstones were true Equisetaceae, those with the thick, woody cylinders being mere exogens of another type. His conclusion that they were gymnosperms was a purely hypothetical one, since justified by no one feature of their organization.

My researches, based upon a vast number of specimens of all sizes, from minute twigs little more than the thirtieth of an inch in diameter to thick stems

[1] Memoirs i., ix., and xii.

[2] Zur morphologie der calamarien.

at least thirteen inches across, led me to the conclusion that we have but one type of calamite, and that the differences which misled Brongniart are merely due to variations in the mode of their preservation.[1] It became clear to me that the outer surface of the coaly film in the specimens preserved in the shales and sandstones did *not* represent the outer surface of the living plant, but was only a fractional remnant of the carbon of that plant, which had undergone a complete metamorphosis. The greater part of what originally existed had disappeared, probably in a gaseous state; and the little that remained, displaying no organic structure, *had been moulded upon the underlying inorganic cast of the medullary cavity.* This cast is always fluted longitudinally, and constructed transversely at intervals of varying lengths. Both these features were due to impressions made by the organism upon the inorganic sand or mud filling the medullary cavity whilst it was in a plastic state, and which subsequently became more or less hardened; the longitudinal grooves being caused by the pressure of the inner angles of the numerous longitudinally vascular wedges, and the transverse ones partly by the remains of a cellular nodal diaphragm which crossed the fistular medullary cavity, and partly by a centripetal encroachment of the vascular zone at each of the same points.[2]

My cabinets contain an enormous number of sections of these plants, in which the minutest details of their organization are exquisitely preserved. These specimens, as already observed, show their structure in every stage of their growth, — from the minutest twigs, to stems more than a foot in diameter. Yet these various examples are all, without a solitary exception, constructed upon one common plan. That plan is an extremely complicated one, — far too complex to make it in the slightest degree probable that it could co-exist in two such very different orders of plants as the Equisetaceae and the Gymnospermae. Yet, though very complex, it is, even in many of its minuter details, unmistakably the plan upon which the living equisetums are constructed. The resemblances are too clear, as well as too remarkable, in my mind, to leave room for any doubt on this point. The great differences are only such as necessarily resulted from the gradual attainment of the arborescent form so unlike the lowly herbaceous one of their living representatives. On the other hand, no living gymnosperm possesses an organization that *in any solitary feature* resembles that of the so-called Calamodendra. The two have absolutely nothing in common: hence the conclusion that these Calamodendra were gymnospermous plants is as arbitrary an assumption as could possibly be forced upon science, — an assumption that no arguments derived from the merely external aspects of structureless specimens could ever induce me to accept.

These Calamites exhibit a remarkable morphological characteristic, which presents itself to us here for the first time, but which we shall find recurs in other paleozoic forms. Some of our French botani-

[1] Memoirs i. and ix.

[2] See Memoir i., pl. xxiv., fig. 10; and pl. xxvi., fig. 24.

cal friends group the various structures contained in plants into several 'appareils,'[1] distinguished by the functions which those structures have to perform. Amongst others, we find the 'appareil de soutiens,' embracing those hard, woody tissues which may be regarded as the supporting skeleton of the plant, and the 'appareil conducteur,' which M. van Tieghem describes as composed of two tissues, — "le tissu criblé qui transporte essentiellement les matières insolubles, et le tissu vasculaire qui conduit l'eau et les substances dissoutes." Without discussing the scientific limits of this definition, it suffices for my present purpose. In nearly all flowering plants these two 'appareils' are more or less blended. The supporting wood-cells are intermingled in varying degrees with the sap-conducting vessels. It is so, even in the lower gymnosperms; and in the higher ones these wood-cells almost entirely replace the vessels. It is altogether otherwise with the fossil cryptogams. The vascular cylinder in the interior of the Calamites, for example, consists wholly of *barred* vessels, a slight modification of the scalariform type so common in all cryptogams. No trace of the 'appareil de soutiens' is to be found amongst them. The vessels are, in the most definite sense, the 'appareils conducteurs' of these plants. No such absolutely undifferentiated unity of tissue is to be found in any living plants other than cryptogams.

But these Calamites, when living, towered high into the air. My friend and colleague, Professor Boyd Dawkins, recently assisted me in measuring one found in the roof of the Moorside colliery, near Ashton-under-Lyne, by Mr. George Wild, the very intelligent manager of that and some neighboring collieries. The flattened specimen ran obliquely along the roof, each of its two extremities passing out of sight, burying themselves in the opposite sides of the mine. Yet the portion which we measured was thirty feet long; its diameter being six inches at one end, and four inches and a half at the other. The mean length of its internodes at its broader end was three inches, and at its narrower one an inch and a half. What the real thickness of this specimen was when all its tissues were present, we have no means of judging; but the true diameter of the cylinder represented by the fossil when uncompressed has been only four inches at one end of the thirty feet, and two inches and a half at the other. Whatever its entire diameter when living, the vascular cylinder of this stem must have been at once tall and slender, and consequently must have required some 'appareil de soutien' such as its exogenous vascular zone did not supply. This was provided in a very early stage of growth by the introduction of a second cambium-layer into the bark; which, though reminding us of the cork-cambium in ordinary exogenous stems, produced, not cork, but prosenchymatous cells.[2] In its youngest state, the bark of the Calamites was a very loose cellular parenchyma; but in the older stems much of this parenchyma became enclosed in the prosenchymatous tissue referred to, and which appears

[1] Van Tieghem, Traité de botanique, p. 679.
[2] Memoir ix., pl. xx., figs. 14, 15, 18, 19, and 20.

to have constituted the greater portion of the matured bark. The sustaining skeleton of the plant, therefore, was a hollow cylinder, developed centrifugally on the inner side of an enclosing cambium-zone. That this cambium-zone must have had some protective periderm external to *it*, is obvious; but I have not yet discovered what it was like. We shall find a similar cortical provision for supporting lofty cryptogamous stems in the Lepidodendra and Sigillariae.

The carboniferous rocks have furnished a large number of plants having their foliage arranged in verticils, and which have had a variety of generic names assigned to them. Such are Asterophyllites, Sphenophyllum, Annularia, Bechera, Hippurites, and Schizoneura. Of these genera, Sphenophyllum is distinguished by the small number of its wedge-shaped leaves; and the structure of its stems has been described by M. Renault. Annularia is a peculiar form, in which the leaves forming each verticil, instead of being all planted at the same angle upon the central stem, are flattened obliquely nearly in the plane of the stem itself. Asterophyllites differs from Sphenophyllum chiefly in the larger number and in the linear form of its leaves. Some stems of this type have virtually the same structure[1] as those of Sphenophyllum, — a structure which differs widely from that of the Calamites, and of which, consequently, these plants cannot constitute the leaf-bearing branches. But there is little doubt that true calamitean branches have been included in the genus Asterophyllites. I have specimens, for which I am indebted to Dr. Dawson, which I should unhesitatingly have designated Asterophyllites but for my friend's positive statement that he detached them from stems of a calamite. Of the internal organization of the stems of the other genera named, we know nothing.

It is a remarkable fact, that notwithstanding the number of young calamitean shoots that we have obtained from Oldham and Halifax, in which the structure is preserved, we have not met with one with the leaves attached. This is apparently due to the fact that most of the specimens are decorticated ones. We have a sufficient number of corticated specimens to show us what the bark was, but such specimens are not common. They clearly prove, however, that their bark had a smooth, and not a furrowed, external surface.

There yet remains for consideration the numerous reproductive strobili, generally regarded as belonging to plants of this class, Equisetinae. We find some of these strobili associated with stems and foliage of known types, as in Sphenophyllum;[2] but we know nothing of the internal organization of these sphenophylloid strobili. We have strobili connected with stems and foliage of Annularia,[3] but we are equally ignorant of the organization of these. So far as that

[1] Memoir, part v., pl. i.–v.; and part ix., pl. xxi., fig. 32.
[2] Lesquereux, Coal flora of Pennsylvania, pl. ii., fig. 687.
[3] Ueber die fruchtähren von Annularia sphenophylloides. Von T. Sterzel. Zeitschr. d. deutschen geolog. gesellschaft., Jahrg. 1882.

organization can be ascertained from Sterzel's specimen, it seems to have alternating sterile and fertile bracts, with the sporangia of the latter arranged in fours, as in Calamostachys.[1] On the other hand, we are now very familiar with the structure of the Calamostachys Binneana, the prevalent strobilus in the calcareous nodules found in the lower coal-measures of Lancashire and Yorkshire. It has evidently been a sessile spike, the axial structures of which were trimerous[2] (rarely tetramerous), having a cellular medulla in its centre. Its appendages were exact multiples of those numbers. Of the plant to which it belonged we know nothing. On the other hand, we have examples supposed to be of the same genus, as C. paniculata[3] and C. polystachya,[4] united to stems with asterophyllitean leaves; but whether or not these fruits have the organization of C. Binneana, we are unable to say.

We are also acquainted with the structure of the two fruits belonging to the genera Bruckmannia[5] and Volkmannia.[6] This latter term has long been very vaguely applied.

There still remain the genera Stachannularia, Palaeostachya, Macrostachya, Cingularia, Huttonia, and Calamitina, all of which have the phyllomes of their strobili fertile and sterile, arranged in verticils, and some of them display asterophyllitean foliage. But these plants are only known from structureless impressions. That all these curious spore-bearing organisms have close affinities with the large group of the equisetums cannot be regarded as certain; but several of them undoubtedly have peculiarities of structure suggestive of relations with the Calamites. This is especially observable in the longitudinal canals found in the central axis of each type, apparently identical with what I have designated the internodal canals of the Calamites.[7] The position and structure of their vascular bundles suggest the same relationship, whilst in many the position of the sporangia and sporangiophores is eminently equisetiform. Renault's Bruckmannia Grand-Euryi and B. Decaisnei, and a strobilus which I described in 1870,[8] exhibit these calamitean affinities very distinctly.

One strobilus which I described in 1880[9] must not be overlooked. As is well known, all the living forms of esquisetaceous plants are isosporous. We only discover heterosporous vascular cryptogams amongst the Lycopodiaceae and the Rhizocarpae. My strobilus is identical, in every detailed feature of its organization, with the common Calamostachys Binneana, excepting that it is heterosporous; having microspores in its upper, and macrospores in its lower part, — a state of things suggestive of some link between the Equisetinae and the heterosporous Lycopodiaceae.

*Lycopodiaceae.* — This branch of my subject suggests memories of a long conflict, which, though it is virtually over, still leaves here and there the groundswell of a stormy past. At the meeting of the British association at Liverpool, in 1870, I first announced that a thick, secondary, exogenous growth of vascular tissue existed in the stems of many carboniferous cryptogamic plants, especially in the calamitean and lepidodendroid forms. But at that time the ideas of M. Brongniart were so entirely in the ascendant, that my notions were rejected by every botanist present. Though the illustrious French paleontologist knew that such growths existed in Sigillariae and in what he designated Calamodendra, he concluded, that, *de facto*, such plants could not be cryptogams. Time, however, works wonders. Evidence has gradually accumulated, proving, that, with the conspicuous exception of the ferns, nearly every carboniferous cryptogam was capable of developing such zones of secondary growth. The exceptional position of the ferns still appears to be as true as it was when I first proclaimed their exceptional character at Liverpool. At that time I was under the impression that the secondary wood was only developed in such plants as attained to arboreal dimensions; but I soon afterwards discovered that it occurred equally in many small plants like Sphenophyllum, Asterophyllites, and other diminutive types.

After thirteen years of persevering demonstration, these views, at first so strongly opposed, have found almost universal acceptance; nevertheless, there still remain some few who believe them to be erroneous ones. In the later stages of this discussion the botanical relations subsisting between Lepidodendron, Sigillaria, and Stigmaria, have been the chief themes of debate. In this country we regard the conclusion, that Stigmaria is not only a root, but the root alike of Lepidodendron and Sigillaria, as settled beyond all dispute. Nevertheless, M. Renault and M. Grand-Eury believe that it is frequently a leaf-bearing rhizome, from which aerial stems are sent upwards. I am satisfied that there is not a shadow of foundation for such a belief. The same authors, along with their distinguished countryman the Marquis de Saporta, believe with Brongniart that it is possible to separate Sigillaria widely from Lepidodendron. They leave the latter plant amongst the lycopods, and elevate the former to the rank of a gymnospermous exogen. I have in vain demonstrated the existence of a large series of specimens of the same species of plant, young states of which display all the essential features of structure which they believe to characterize Lepidodendron; whilst, in its progress to maturity, every stage in the development of the secondary wood, regarded by them as characteristic of a Sigillaria, can be followed step by step.[1] Nay, more. My cabinet contains specimens of young dichotomously branching twigs, on

[1] M. Renault has described a strobilus under the name of Annularia longifolia, but which appears to me very distinct from that genus.

[2] It is an interesting fact, that transverse sections of the strobili of Lycopodium alpinum exhibit a similar trimerous arrangement, though differing widely in the positions of its sporangia.

[3] Weiss, Abhandlungen zur geologischen specialkarte von Preussen und Thüringischen Staaten, taf. xiii., fig 1.

[4] *Idem*, taf. xvi., figs. 1, 2.

[5] Renault, Annales de sciences naturelles, bot., tome iii., pl. iii.

[6] *Idem*, pl. ii.

[7] Memoir i.

[8] Memoirs of the literary and philosophical society of Manchester, 3d series, vol. iv. p. 248.

[9] Memoir xi., pl. liv., figs. 23, 24.

[1] Memoir xi., plates xlvii.–lii.

which one of the two diverging branches has only the centripetal cylinder of the Lepidodendron, whilst the other has begun to develop the secondary wood of the Sigillaria.[1]

The distinguished botanist of the Institut, Ph. van Tieghem, has recently paid some attention to the conclusions adopted by his three countrymen in this controversy, and has made an important advance upon those conclusions, in what I believe to be the right direction. He recognizes the lycopodiaceous character of the Sigillariae, and their close relations to the Lepidodendra;[2] and he also accepts my demonstration of the unipolar, and consequently lycopodiaceous, character of the fibro-vascular bundle of the stigmarian rootlet, — a peculiarity of structure of which M. Renault has hitherto denied the existence. But along with these recognitions of the accuracy of my conclusions, he gives fresh currency to several of the old errors relating to parts of the subject to which he has not yet given personal attention. Thus he considers that the Sigillariae, though closely allied to the Lepidodendra, are distinguished from them by possessing the power of developing the centrifugal or exogenous zone of vascular tissue already referred to. He characterizes the Lepidodendra as having '*un seul bois centripète*,' notwithstanding the absolute demonstrations to the contrary contained in my Memoir xi. Dealing with the root of Sigillaria, which in Great Britain, at least, is the well-known Stigmaria ficoides, following Renault, he designates it a 'rhizome,' limiting the term 'root' to what we designate the rootlets. He says, "Le rhizome des sigillaires a la même structure que la tige aérienne, avec des bois primaires tantôt isolés à la périphérie de la moelle, tantôt confluents au centre et en un ax plein; seulement les fasceaux libéro-ligneux secondaires y sont séparés par de plus larges rayons," etc.

Now, Stigmaria, being a root, and not a rhizome, contains no representative of the primary wood of the stem. This latter is, as even M. Brongniart so correctly pointed out long ago, the representative of the medullary sheath; and the fibro-vascular bundles which it gives off are all foliar ones, as is the case with the bundles given off by this sheath in all exogenous plants. But in the Lepidodendra and Sigillariae, as in all living exogens, it is not prolonged into the root. In the latter, as might be expected *a priori*, we only find the secondary or exogenous vascular zone. Having probably the largest collection of sections of Stigmariae in the world, I speak unhesitatingly on these points. M. van Tieghem further says, "La tige aérienne part d'un rhizome rameux très-développé nommé Stigmaria, sur lequel s'insèrent à la fois de petites feuilles et des racines parfois dichotomées." I have yet to see a solitary fact justifying the statement that leaves are intermingled with the rootlets of Stigmaria. The statement rests upon an entire misinterpretation of sections of the fibro-vascular bundles supplying those rootlets, and an ignorance of the nature and positions of the rootlets themselves. More than forty years have elapsed since John Eddowes Bowman first demonstrated that the Stigmariae were true roots; and every subsequent British student has confirmed Bowman's accurate determination.

[1] Memoir xi., pl. xlix., fig. 8.
[2] Traité de botanique, p. 304.

M. Lesquereux informs me that his American experiences have convinced him that Sigillaria is lycopodiaceous. Dr. Dawson has now progressed so far in the same direction as to believe that there exists a series of sigillarian forms which link the Lepidodendra on the one hand with the gymnospermous exogens on the other. As an evolutionist, I am prepared to accept the possibility that such links may exist. They certainly do, so far as the union of Lepidodendron with Sigillaria is concerned. I have not yet seen any from the higher part of the chain that are absolutely satisfactory to me, but Dr. Dawson thinks that he has found such. I may add, that Schimper and the younger German school have always associated Sigillaria with the Lycopodiaceae; but there are yet other points under discussion connected with these fossil lycopods.

M. Renault affirms that some forms of Halonia are subterranean rhizomes, and the late Mr. Binney believed that Haloniae were the roots of Lepidodendron. I am not acquainted with a solitary fact justifying either of these suppositions, and unhesitatingly reject them. We have the clearest evidence that some Haloniae, at least, are true terminal, and, as I believe, strobilus-bearing, branches of various lepidodendroid plants; and I see no reason whatever for separating Halonia regularis from those whose fruit-bearing character is absolutely determined. Its branches, like the others, are covered throughout their entire circumference, and in the most regularly symmetrical manner, with leaf-scars, — a feature wholly incompatible with the idea of the plant being either a root or a rhizome. M. Renault has been partly led astray in this matter by misinterpreting a figure of a specimen published by the late Mr. Binney. That specimen being now in the museum of Owens college, we are able to demonstrate that it has none of the features which M. Renault assigns to it.

The large, round or oval, distichously arranged scars of Ulodendron have long stimulated discussion as to their nature. This, too, is now a well-understood matter. Lindley and Hutton long ago suggested that they were scars whence cones had been detached, — a conclusion which was subsequently sustained by Dr. Dawson and Schimper,[1] and which structural evidence led me also to support. The matter was set at rest by Mr. d'Arcy Thompson's discovery of specimens with the strobili *in situ*. Only a small central part of the conspicuous cicatrix characterizing the genus represented the area of organic union of the cone to the stem. The greater part of that cicatrix has been covered with foliage, which, owing to the shortness of the cone-bearing branch, was compressed by the base of the cone. The large size of many of these biserial cicatrices on old stems has been due to the considerable growth of the stem subsequently to the fall of the cone.

Our knowledge of the terminal branches of the

[1] Memoir ii., p. 222.

large-ribbed Sigillariaé is still very imperfect. Paleontologists who have urged the separation of the Sigillariae from the Lepidodendra have attached weight to the difference between the longitudinally ridged and furrowed external bark of the former plants, along which ridges the leaf-scars are disposed in vertical lines, and the diagonally arranged scars of Lepidodendron. They have also dwelt upon the alleged absence of branches from the sigillarian stems. I think that their mistake, so far as the branching is concerned, has arisen from their expectation that the branches must necessarily have had the same vertically grooved appearance and longitudinal arrangement of the leaf-scars as they observed in the more aged trunks: hence they have probably *seen* the branches of Sigillariae without *recognizing* them. Personally, I believe this to have been the case. I further entertain the belief, that the transition from the *vertical* phyllotaxis, or leaf-arrangement, of the sigillarian leaf-scars, to the *diagonal* one of the Lepidodendra, will ultimately be found to be effected through the subgenus Favularia, in many of which the diagonal arrangement becomes quite as conspicuous as the vertical one. This is the case even in Brongniart's classic specimen of Sigillaria elegans, long the only fragment of that genus known, which preserved its internal structure. The fact is, the shape of the leaf-scars, as well as their proximity to each other, underwent great changes as lepidodendroid and sigillarian stems advanced from youth to age. Thus Presl's genus Bergeria was based on forms of lepidodendroid scars which we now find on the terminal branches of unmistakable lepidodendra.[1] The phyllotaxis of Sigillaria, of the type of S. occulata, passes by imperceptible gradations into that of Favularia. In many young branches the leaves were densely crowded together; but the exogenous development of the interior of the stem, and its consequent growth both in length and thickness, pushed these scars apart at the same time that it increased their size and altered their shape. We see precisely the same effects produced upon the large fruit-scars of Ulodendron by the same causes. The carboniferous lycopods were mostly arborescent; but some few dwarf forms, apparently like the modern Selaginellae, have been found in the Saarbrücken coal-fields. Many, if not all, the arborescent forms produced secondary wood by means of a cambium-layer, as they increased in age. In the case of some of them,[2] this was done in a very rudimentary manner; nevertheless, sufficiently so to demonstrate what is essential to the matter, viz., the existence of a cambium-layer producing 'centrifugal growth of secondary vascular tissue.'

As already pointed out in the case of the Calamites, the vascular axis of these Lepidodendra was purely an 'appareil conducteur,' unmixed with any wood-cells: hence the 'appareil de soutien' had to be supplied elsewhere. This was done as in the Calamites: a thick, persistent, hypodermal zone of meristem[3]

[1] See Memoir xii., pl. xxxiv.

[2] E. g. L. Harcourtii, Memoir ix., pl. xlix., fig. 11.

[3] Memoir ix., pl. xxv., figs. 93, 94, 98, 99, 100, and 101.

developed a layer of prismatic prosenchyma of enormous thickness,[1] which incased the softer structures in a strong cylinder of self-supporting tissue. We have positive evidence that the fructification of many of these plants was in the form of heterosporous strobili. Whether or not such was the case with all the Lepidostrobi, we are yet unable to determine; but the incalculable myriads of their macrospores, seen in so many coals, afford clear evidence that the heterosporous types must have preponderated vastly over all others.

*Gymnosperms.* — Our knowledge of this part of the carboniferous vegetation has made great progress during the last thirty years. This progress began with my own discovery[2] that all our British Dadoxylons possessed what is termed a discoid pith, such as we see in the white jasmine, some of the American hickories, and several other plants. At the same time, I demonstrated that most of our objects hitherto known as Artisias and Sternbergias were merely inorganic casts of these discoid medullary cavities. Further knowledge of this genus seems to suggest that it was not only the oldest of the true conifers in point of time, but also one of the lowest of the coniferous types.

*Cycads.* — The combined labors of Grand-Eury, Brongniart, and Renault, have revealed the unexpected predominance in some localities of a primitive but varied type of cycadean vegetation. Observers have long been familiar with certain seeds known as Trigonocarpons and Cardiocarpons, and with large leaves to which the name of Noeggerathia was given by Sternberg. All these seeds and leaves have been tossed from family to family at the caprice of different classifiers, but, in all cases, without much knowledge on which to base their determinations. The rich mass of material disinterred by M. Grand-Eury at St. Étienne, and studied by Brongniart and M. Renault, has thrown a flood of light upon some of these objects, which now prove to be primeval types of cycadean vegetation.

Mr. Peach's discovery of a specimen demonstrating that the Antholithes Pitcairniae[3] of Lindley and Hutton was not only, as these authors anticipated, 'the inflorescence of some plant,' but that its seeds were the well-known Cardiocarpons, was the first link in an important chain of new evidence. Then followed the rich discoveries at St. Étienne, where a profusion of seeds, displaying wonderfully their internal organization, was brought to light by the energy of M. Grand-Eury; which seeds M. Brongniart soon pronounced to be cycadean. At the same time I was obtaining many similar seeds from Oldham and Burntisland, in which, also, the minute organiza-

[1] Memoir xi., pl. xlviii., fig. 4 *f f'*; Memoir ii., pl. xxix., fig. 42 *k*; Memoir iii., pl. xliii., fig. 17.

[2] On the structure and affinities of the plants hitherto known as Sternbergias. Memoirs of the literary and philosophical society of Manchester, 1851. M. Renault, in his Structure comparée de quelques tiges de la flore carbonifère, p. 285, has erroneously attributed this discovery to Mr. Dawes, including my illustration from the jasmine and juglans. Mr. Dawes' explanation was a very different one.

[3] Fossil flora, p. 82.

tion was preserved. Dawson, Newberry, and Lesquereux have also shown that many species of similar seeds, though with no traces of internal structure, occur in the coal-measures of North America.

Equally important was the further discovery by M. Grand-Eury, that the Antholithes, with their cardiocarpoid seeds, were but one form of the monoclinous catkin-like inflorescences of the Noeggerathiae, now better known by Unger's name of Cordaites. These investigations suggest some important conclusions. 1°. The vast number and variety of these cycadean seeds, as well as the enormous size of some of them, are remarkable, showing the existence of an abundant and important carboniferous vegetation, of most of which no trace has yet been discovered other than these isolated seeds. 2°. Most of the seeds exhibit the morphological peculiarity of having a large cavity (the 'cavité pollinique' of Brongniart) between the upper end of the nucelle and its investing episperm, and immediately below the micropile of the seed. That this cavity was destined to have the pollen-grains drawn into it, and be thus brought into direct connection with the apex of the nucelle, is shown by the various examples in which such grains are still found in that cavity.[1] 3°. M. Grand-Eury has shown that some of his forms of Cordaites possessed the discoid or Sternbergian pith which I had previously found in Dadoxylon. And, lastly, these Cordaites prove that a diclinous form of vegetation existed at this early period in the history of the flowering plants, but whether in a monoecious or a dioecious form we have as yet no means of determining. Their reproductive structures differ widely from the true cones borne by most cycads at the present day.

*Conifers.* — It has long been remarked that few real cones of conifers have hitherto been found in the carboniferous rocks, and I doubt if any such have yet been met with. Large quantities of the woody stems now known as Dadoxylons have been found, both in Europe and America. These stems present a true coniferous structure, both in the pith, medullary, sheath-wood, and bark.[2] The wood presents one very peculiar feature: its foliar bundles, though in most other respects exactly like those of ordinary conifers, are given off, not singly, but in pairs.[3] I have only found this arrangement of double foliar bundles in the Chinese gingko (Salisburia adiantifolia).[4] This fact is not unimportant when connected with another one. Sir Joseph Hooker long ago expressed his opinion that the well-known Trigonocarpons[5] of the coal-measures were the seeds of a conifer allied to this Salisburia. The abundance of the fragments of Dadoxylon, combined with the readiness with which cones and seeds are preserved in a fossil state, makes it probable that the fruits belonging to these woody stems would be so preserved; but of cones we find no trace, and, as we discover no other plant in the carboniferous strata to which the Trigonocarpons could with any probability have belonged, these facts afford grounds for associating them with the Dadoxylons. These combined reasons — viz., the structure of the stems with their characteristic foliar bundles, and the gingko-like character of the seeds — suggest the probability that these Dadoxylons, the earliest of known conifers, belonged to the Taxineae, the lowest of these coniferous types, and of which the living Salisburia may perhaps be regarded as the least advanced form.

Thus far our attention has been directed only to plants whose affinities have been ascertained with such a degree of probability as to make them available witnesses, so far as they go, when the question of vegetable evolution is *sub judice*. But there remain others, and probably equally important ones, respecting which we have yet much to learn. In most cases we have only met with detached portions of these plants, such as stems or reproductive structures, which we are unable to connect with their other organs. The minute tissues of these plants are preserved in an exquisite degree of perfection: hence we are able to affirm, that, whatever they may be, they differ widely from every type that we are acquainted with amongst living ones. The exogenous stems or branches from Oldham and Halifax which I described under the name of Astromyelon,[1] and of which a much fuller description will be found in my forthcoming Memoir xii., belong to a plant of this description. The remarkable conformation of its bark obviously indicates a plant of more or less aquatic habits, since it closely resembles those of Myriophyllum, Marsilea, and a number of other aquatic plants belonging to various classes. But its general features suggest nearer affinities to the latter genus than to any other. Another very characteristic stem is the Heterangium Grievii,[2] only found in any quantity at Burntisland, but of which we have recently obtained one or two small specimens at Halifax. This plant displays an abundant supply of primary, isolated, vascular bundles, surrounded by a very feeble development of secondary vascular tissue. Still more remarkable is the Lyginodendron Oldhamium,[3] a stem not uncommon at Oldham, and not unfrequently found at Halifax. Unlike the Heterangium, its primary vascular elements are feeble, but its tendency to develop secondary zylem is very characteristic of the plant. An equally peculiar feature is seen in the outermost layer of its cellular bark, which is penetrated by innumerable longitudinal laminae of prosenchymatous tissue, which is arranged in precisely the same way as is the hard bast in the lime and similar trees, affording another example of the introduction into the outer bark of the 'appareil de soutien.' As might have been anticipated from this addition to the bark, this plant attained arborescent dimensions, very large

[1] Memoir viii., pl. ii., figs. 70 and 72. Brongniart, Recherches sur les graines fossiles silicifiées, pl. xvi., figs. 1, 2; pl. xx., fig. 2.
[2] Dr. Dawson finds the discoid pith in one of the living Canadian conifers.
[3] Memoir viii., pl. lviii., fig. 48; and pl. ix., figs. 44-46.
[4] Memoir xii., pl. xxxiii., figs. 28, 29.
[5] Memoir viii., figs. 94-115.

[1] Memoir ix., in which I only described decorticated specimens. Messrs. Cash and Heik described a specimen in which the peculiar bark was preserved under the name of Astromyelon Williamsonis. See Proceedings of the Yorkshire polytechnic society, vol. vii. part iv., 1881.
[2] Memoir iii. [3] *Ibid.*

fragments of sandstone casts of the exterior surface of the bark[1] being very abundant in most of the leading English coal-fields. Corda also figured it[2] from Radnitz, confounding it, however, with his lepidodendroid Sagenaria fusiformis, with which it has no true affinity. Of the smaller plants of which we know the structure, but not the systematic position, I may mention the beautiful little Kaloxylons.[3] We have also obtained a remarkable series of small spherical bodies, to which I have given the provisional generic name of Sporocarpon.[4] Their external wall is multicellular: hence they cannot be spores. Becoming filled with free cells, which display various stages of development as they advance to maturity, we may infer that they are reproductive structures. Dr. Dawson informs me that he has recently obtained some similar bodies, also containing cells, from the Devonian beds of North and South America. Except in calling attention to some slight resemblance existing between my objects and the sporangiocarps of Pilularia,[5] I have formed no opinion respecting their nature. Dr. Dawson has pointed out that his specimens, also, are suggestive of relations with the Rhizocarpae.

I am unwilling to close this address without making a brief reference to the bearing of our subject upon the question of evolution. Various attempts have been made to construct a genealogical tree of the vegetable kingdom. That the cryptogams and the gymnosperms made their appearance, and continued to flourish on this earth, long prior to the appearance of the monocotyledonous and dicotyledonous flowering plants, is, at all events, a conclusion justified by our present knowledge, so far as it goes. Every one of the supposed palms, aroids, and other monocotyledons, has now been ejected from the lists of carboniferous plants, and the Devonian rocks are equally devoid of them. The generic relations of the carboniferous vegetation to the higher flowering plants found in the newer strata have no light thrown upon them by these paleozoic forms. These latter do afford us a few plausible hints respecting some of their cryptogamic and gymnospermous descendants, and we know that the immediate ancestors of many of them flourished during the Devonian age; but here our knowledge practically ceases. Of their still older genealogies, scarcely any records remain. When the registries disappeared, not only had the grandest forms of cryptogamic life that ever lived attained their highest development, but even the yet more lordly gymnosperms had become a widely diffused and flourishing race. If there is any truth in the doctrine of evolution, and especially if long periods of time were necessary for a world-wide development of lower into higher races, a terrestrial vegetation must have existed during a vast succession of epochs, ere the noble lycopods began their prolonged career. Long prior to the carboniferous age they had not only made this beginning, but during that age they had diffused themselves over the entire earth. We find them equally in the old world and in the new. We discover them from amid the ice-clad rocks of Bear Island and Spitzbergen to Brazil and New South Wales. Unless we are prepared to concede that they were simultaneously developed at these remote centres, we must recognize the incalculable amount of time requisite to spread them thus from their birthplace, wherever that may have been, to the ends of the earth. Whatever may have been the case with the southern hemisphere, we have also clear evidence that in the northern one much of this wide distribution must have been accomplished prior to the Devonian age. What has become of this pre-Devonian flora? Some contend that the lower cellular forms of plant-life were not preserved, because their delicate tissues were incapable of preservation. But why should this be the case? Such plants are abundantly preserved in tertiary strata: why not equally in paleozoic ones? The explanation must surely be sought, not in their incapability of being preserved, but in the operation of other causes. But the carboniferous rocks throw another impediment in the way of constructors of these genealogical trees. Whilst carboniferous plants are found at hundreds of separate localities, widely distributed over the globe, the number of spots at which these plants are found displaying any internal structure is extremely few. It would be difficult to enumerate a score of such spots; yet each of those favored localities has revealed to us forms of plant-life of which the ordinary plant-bearing shales and sandstones of the same localities show no traces. It seems, therefore, that, whilst there was a general resemblance in the more conspicuous forms of carboniferous vegetation from the arctic circle to the extremities of the southern hemisphere, each locality had special forms that flourished in it either exclusively, or at least abundantly, whilst rare elsewhere. It would be easy, did time allow, to give many proofs of the truth of this statement. Our experiences at Oldham and Halifax, at Arran and Burntisland, at St. Étienne and Autun, tell us that such is the case. If these few spots which admit of being searched by the aid of the microscope have recently revealed so many hitherto unknown treasures, is it not fair to conclude that corresponding novelties would have been furnished by all the other plant-producing localities, if these plants had been preserved in a state capable of being similarly investigated? I have no doubt about this matter: hence I conclude that there is a vast variety of carboniferous plants of which we have as yet seen no traces, but every one of which must have played some part, however humble, in the development of the plant races of later ages. We can only hope that time will bring these now hidden witnesses into the hands of future paleontologists. Meanwhile, though far from wishing to check the construction of any legitimate hypothesis calculated to aid scientific inquiry, I would remind every too ambitious student that there is a haste that retards rather than promotes progress, that arouses opposition rather than produces conviction, and that injures the cause of science by discrediting its advocates.

[1] Memoir iv., pl. xxvii.
[2] Flora der vorvelt, tab. 6, fig. 4.
[3] Memoir vii.
[4] Memoirs ix., x.
[5] Memoir ix., p. 348.

## *LETTERS TO THE EDITOR.*

### Greenland geology.

IN the seventh volume of Heer's Flora fossilis arctica, just issued, my distinguished colleagues, Professor Heer of Zurich, and Herr K. F. V. Steenstrup of Copenhagen, seem to be at cross purposes with me, regarding the positions and Eskimo names of the localities where the collections of fossil plants discovered by us were obtained; Mr. Steenstrup giving the spot one name, and I another, while, owing to this misapprehension, the exact latitude of at least one place is differently entered in our respective papers. For instance: we apply the name of 'Kudlisaet' (Kitludsat) to spots at considerable distances from each other, and do not quite understand the same place by the word 'Unartok.' Heer, who has, however, never been in Greenland, notes (p. 203) that "nach Steenstrup fällt Ujarasuksumitok von R. Brown (Flora foss. arct., ii. p. 452) mit Unartok zusammen und der Name beruht auf missverständniss." Again: Steenstrup, in the admirable memoir appended to Heer's work, mentions that "Brown zufolge *l. c.* [*Philosophical transactions*, 1869, p. 445, and *Transactions of the geological society of Glasgow*, vol. v. p. 36], war es hier [at Unartok], dass er und Whymper im jahr 1867 versteinerungen sammelten. Meines erachtens rüht der name Browns 'Uiarasuksumitok' von dem umstande her, dass der Grönlander ihn missverstanden und geglaubt hat, dass er gefragt würde, woher er (der Grönlander) wäre, worauf er eine antwort gab, die ungefähr bedeutet 'Ich bin aus Ujaragsugsuk'" (p. 247). I do not doubt for a moment that Mr. Steenstrup may be right; and his general accuracy forbids me to assert that he is wrong. My acquaintance with Danish was in 1867 (as it is still) trifling, while of Eskimo I was all but ignorant. And even with the greatest care, it is always difficult to arrive at the exact designation of localities in Greenland. However, Mr. Tegner, who accompanied us, was familiar with Eskimo, and of course, as a Dane, with Danish; and the names attached to my map and paper referred to were arrived at, after repeated cross-questioning of our native boatmen, and of Paulus, the intelligent Eskimo catechist at Ounartok (Unartok), who wrote them down in a note-book, at present before me. Curiously enough, in a note in the hand-writing of the late Chevalier Olrick, so many years governor of North Greenland, the place is called 'Ujarasaksumitok,' which naturally led me to believe that this was a synonyme of Ujaragsugsuk, under which name it is also designated by Dr. Rink, in my edition of Danish Greenland (p. 349). 'Ritenbenks Kolbroff' I regarded as the same place as Unartok, for there coal was being mined; while Steenstrup seems to consider it the same as Kudlisaet. The latter spot, after a series of very careful, and, I am certain, accurate, meridian altitudes, I place in Lat. 70° 5′ 35″ N., while Nares puts the Ritenbenk coal-mine, so called (Kudlisaet), in Lat. 70° 3′ 4″, which convinces me that this spot is what I took to be Unartok. At my Kudlisaet there was, in 1867, no coal being dug. Anyhow, in the 'Geological notes on the Noursoak Peninsula, Disco Island, etc.' (*Trans. geol. soc. Glasgow*, vol. v. p. 55), I have so fully described these localities, that no future explorer can mistake them. But as many may see Heer's work who may not be able to consult my humbler brochure, I ask permission to make these explanations in the columns of a scientific journal, which, as the mouthpiece of American geologists, takes cognizance of far-away Greenland also. Moreover, as one might suppose, from Mr. Steenstrup's (inadvertently, no doubt) mentioning that Nares and I differed two minutes and thirty-one seconds (2′ 31″) in our latitudes of 'Ritenbenks Kohlenbruch,' that there was some *inexcusable roughness* in the use of the sextant and artificial horizon, while in reality we observed *at two totally different places*, the matter is, though not of great scientific or geographical importance, in a manner personal to myself, if not to Sir George Nares.

ROBERT BROWN.

Streatham, London, Eng.,
Sept. 24, 1883.

### Human proportion.

In a review of my lecture on 'Human proportion in art and anthropometry' (SCIENCE, ii. 354), the accuracy of certain statements contained therein is questioned. Permit me space for a brief reply.

The critic says that the implement in the hand of the Egyptian figure is a *crux ansata*, the symbol of eternity, and not 'a key.' But M. Charles Blanc, whose description I was quoting, says 'la personnage tient *une clef* de la main droite;' and the expression is warranted, as it is, in its symbolical sense, spoken of by Egyptologists as 'a key.'

His next assertion is, that the Doryphorus of Polykleitus was not, as I stated, 'a beautiful youth in the act of throwing a spear,' but a spear-bearer of the body-guard of the Persian king. The latter functionary, however, wore a long robe, termed the 'candys,' extending from the neck to the mid-leg, and could not have been selected for a model, which necessarily required a naked figure. Pliny (Hist. nat., xxxiv. 8) says, 'Idem et Doryphorum *viriliter puerum* fecit,' etc.; and many other allusions in classical writers confirm this view.

The last and most surprising criticism is the statement that my assertion that prior to the time of Phidias, the face, hands, feet, etc., were carved in marble, and were fastened to a wooden block, is "a complete misunderstanding of the nature of the archaic *ξόανα*, or wooden statues, which in Greece preceded those made of stone or metal." Now, the *ξόανον* was simply a wooden statue. (Cf. Pausanias, vii., 17, 2, *τοσάδε ἦν ἀφ' ὧν τὰ ξόανα*, etc.) It was succeeded by a more elaborate invention, known as an *acrolith*, from *ἄκρος* and *λίθος*, *stone-ends*. Pausanias describes one of them (ix. 4): "The statue of the goddess [the Plataean Athena of Phidias] is made of wood, and is gilt, except the face, and the ends of the hands and feet, which are of Pentelican stone." See also Quatremère de Quincy. Monuments et ouvrages d'art antiques, vol. ii., Restitution de la Minerve en or et ivoire de Phidias au Parthenon, pp. 63–123; also Müller, Handbuch d. archaeol. d. kunst, § 84. Dr. William Smith states the case concisely (Dict. Gr. and Rom. mythol., vol. iii. p. 250): "Up to his [Phidias's] time, colossal statues, when not of bronze, were *acroliths*; that is, only the face, hands, and feet were of marble, the body being of wood, which was concealed by real drapery."

ROBERT FLETCHER.

Washington, Oct. 8, 1883.

[The most common of all the Egyptian symbols is an emblem in the form of 'a handled cross,' symbolical of 'life;' but both the nature of the object represented, and the reason of the symbolism, are equally unknown. To call it 'a key' is certainly wrong, as the Egyptians had none; and by archeologists it is usually designated by the conventional term '*crux ansata*.'

That the word 'Doryphoros,' *ex vi termini*, cannot mean 'a youth in the act of *throwing* a spear,' as Mr.

Fletcher says, but simply a 'spear-bearer,' is what our criticism was intended to convey.

Although it may be true enough that 'prior to the time of Phidias, *colossal* statues, when not of bronze, were *acroliths*, our criticism was directed to the author's broad assertion, which entirely ignored the existence of *ξόανα*.]

WRITER OF THE NOTICE OF 'HUMAN PROPORTION.'

### Geology of Philadelphia.

Will Professor Henry Carvill Lewis state where the term 'hydro-mica-slate' is used by H. D. Rogers, or in that portion of the report on Chester county written by the undersigned?

The word occurs seven times in the Lancaster county report; but in every case except the italics on p. 10, which the reference on the ninth line below shows to be a misprint, it is used in the sense defined in my criticism, and not as an equivalent for hydro-mica-schist. As his defence of the use of the other terms alluded to does not meet the objections, no further remark is necessary.

PERSIFOR FRAZER.

Sept. 28, 1883.

### The chinch-bug in New York.

We have the chinch-bug (Blissus leucopterus Say) in New York in formidable numbers. Its appearance with us is of great interest, as hitherto the only record of its occurrence is that of Dr. Fitch, who, several years ago, saw three individuals of it upon willows in the spring. I had never before met with it in our state. Dr. Harris, you will remember, mentions having seen one example in Massachusetts. By some manner it has been introduced here, and I can think of no way so probable as that it has been brought in a freight-car from the west.

The locality of its occurrence is in St. Lawrence county, the most western of our northern counties. As it was for some time thought that the insect could not live north of 40° of latitude, this seems a strange locality for its first appearance.

Its operations were first noticed in a field of timothy-grass last summer, but the depredator was not then discovered. This summer the infested area had largely extended, and, upon a more thorough search being made, it was found in myriads — could be scooped up, it is stated, by handfuls — among the roots of the living grass bordering the killed area. In the fields infested, the timothy, June, and 'wire grass' are completely killed, so that they are succeeded the following season by thistles, weeds, and patches of clover. So far, it has not attacked wheat or corn, of which, however, very little is grown in St. Lawrence county.

I have just visited the infested locality, and I find it to be a very serious attack. It is rapidly extending to other than the two farms upon which it was observed last year, and it in all probability exists in many places where it has not yet been detected. Great alarm is felt throughout the district invaded, as the timothy-grass is the foundation of the grazing interests of that region. Clover, owing to the severity of the winters, cannot be grown to any extent. The most threatening feature of the attack is, that it has continued to increase, notwithstanding that this year and the preceding have both been unusually wet in northern New York. Garden-crops were killed by the heavy and continued rains; grass is lying in the meadows, which could not be secured; and so cold has the season been, that fields of oats are still unharvested. All writers have concurred in stating that the chinch-bug could not endure cold and wet seasons, and that heavy rains were invariably fatal to it. It really seems as if the new-comer was destined to be a permanent institution in the state.

The farmers are aroused to the importance of doing what they can to arrest and repel the invasion. I have recommended that it be fought with that valuable insecticide, kerosene-oil, emulsified and diluted; and, if generally used the ensuing spring, I have great faith in its proving efficient.

J. A. LINTNER.

Office of the state entomologist
Albany, Oct. 9, 1883.

### Ziphius on the New-Jersey coast.

A telegram was received at the Smithsonian institution on the 3d inst. from the keeper of the life-saving station at Barnegat City, N.J., announcing the stranding of a large cetacean at that place. Professor Baird immediately despatched the writer and a preparator from the museum to take charge of the specimen. On arriving at Barnegat City, I immediately perceived that we had to do with an example of an aged female of an interesting ziphioid whale; and, when the skull was cut out, it became evident that the animal was of the genus Ziphius. The specimen measures 19 feet 4 inches in length, and was apparently of a light stone-gray color, darkest on the belly. This disposition of color is unusual in cetaceans. The species is probably Z. cavisortris.

Mr. Palmer and myself succeeded in making a plaster mould of half the exterior, and in cutting out the complete skeleton.

The genus Ziphius has not, I believe, been hitherto recorded as occurring in the north-western Atlantic.

FREDERICK W. TRUE,
*Curator of mammals.*

U. S. national museum,
Oct. 11, 1883.

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## THE DE LONG RECORDS.[1]

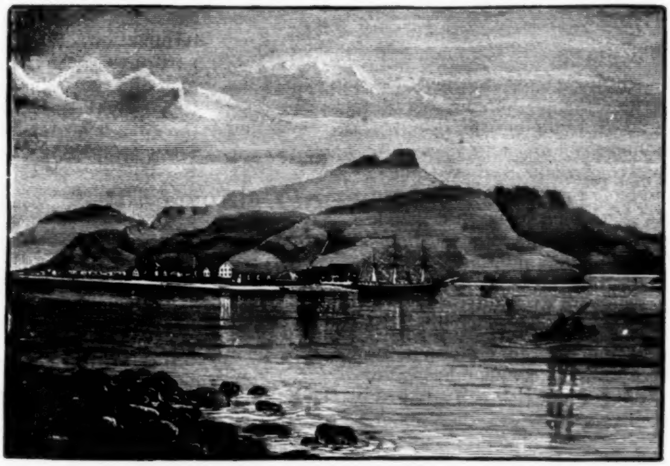
*The voyage of the Jeannette. The ship and ice journals of George W. De Long, Lieut.-commander U.S.N., and commander of the polar expedition of 1879-81.* Edited by his wife, EMMA [JANE WOTTON] DE LONG. 2 vols. Boston, *Houghton, Mifflin, & Co.*, 1883. 12+911 p., illustr. 8°.

THE voyage of the Jeannette, owing to its connection with a great newspaper, has become, in its general features, familiar to all. The courage, endurance, and patience with which the members of the party met pain, peril, privation, and even death, will always remain a conspicuous example of manly quality. This expedition, however, was unique in several of its features, which should be taken into account in any judgment rendered upon its results. It was not an expedition for scientific research in the arctic regions. It was not scientifically planned. It had, so far as can be learned from the documents, no programme. Of its members, but two, a civilian and a seaman, had had any experience of an arctic winter; none had made any serious study of the physical conditions of the polar area; and, without

[1] For the woodcuts illustrating this article, the editor is indebted to the publishers of the work, Messrs. Houghton, Mifflin, & Co.

disrespect, it may be said, that, with the possible exception of two civilians, there was no one on board whose scientific acquirements rose above the daily needs of the intelligent practice of his profession. The object of the expedition, as far as may be surmised from the circumstances made public, seems to have been to determine what would be the result of a set-to between the arctic pack, cold and starvation on the one hand, and a shipful of inexperience and 'pure grit' on the other. The result is now known; and the innocent confidence with which both promoter and explorer undertook the task is one of the extraordinary features of this melancholy history. Under the circumstances, it is well that Mrs. De Long has made public her husband's records of the story, already twice told elsewhere. The account of the voyage is preceded by some details of the previous life of De Long, who, from an early age, showed evidence of great force of will and audacity, and who preserved until his death the religious convictions instilled by a fond and pious mother. There seems to have been no special turn for study in the lad, whose energy, nevertheless, carried him through the Naval academy with credit. The introduction to that friendship with Mr. Bennett which finally led to De Long's selection as commander of the arctic expedition, is left untold. It is evident that these two had a strong and well-founded friendship, and perfect mutual confidence. The voyage once determined upon, Mr. Bennett providing the vessel and the means, the government lending its naval organization and prestige, De Long had only to choose his party, and organize his plans. The first was soon, and, all must admit, remarkably well done. Certainly, no body of men ever stood harder test of fidelity to their commander than that little party, and with less flinching.

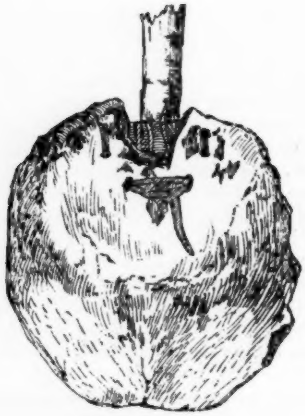
The vessel, it is now generally admitted, was tolerably well adapted to her purpose, and endured from the ice all that could be expected in like circumstances. The provisions, on the whole, turned out well; and the equipment, in the course of the expedition, showed no serious deficiencies. On the whole, then, well provided, and with much popular approbation and sympathy, the expedition departed on the 8th of July, 1879, from San Francisco. A *rendezvous* was had Aug. 2, at Unalaska, — that cosey little harbor which has received so many expeditions, and bravely borne up the barks of Kotzebue, of Lütke, of Levasheff, of Kruzenstern, of Sarycheff, and many more masters of exploration. Ten days afterward they anchored at St. Michael's, Norton Sound. Here dogs, furs, and coal were shipped; and then the Asiatic coast of Bering Strait was reached, and some time spent in endeavoring to determine the fate of Nordenskiöld. Here several


UNALASKA.

curious bone implements were collected, which are figured, but not referred to in the text. One of these we reproduce.

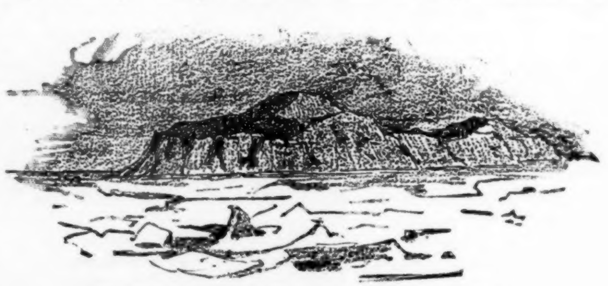
Pushing into the Arctic on Sept. 6, the vessel was beset in the pack north-eastward of Herald Island. From its rigid embrace she was never released, except to sink, a shattered wreck, beneath its surface, nearly two years later.

On Jan. 19, 1880, she received a wrench from an under-running tongue of ice, creating a leak, which remained a more or less constant source of anxiety. From this time until the 16th of May, 1881, the time passed uneventfully; the ship fast in the ice, which occasionally groaned, shrieked, crunched, or thundered, with the various motions imparted to it by wind and tide, threatening instant destruction to ship and party. A few bear and seal hunts, ordinary



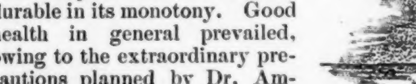
BONE SHOVEL.

meteorological observations, the quarrels of the Eskimo dogs, innumerable devices for saving coal, pumping the ship dry, or preventing condensation of moisture within the living-rooms,— these things, and such as these, made up the characteristics of a life which eventually became almost unendurable in its monotony. Good health in general prevailed, owing to the extraordinary precautions planned by Dr. Ambler, and energetically put in force by the commander. No extreme temperatures (rated by the experience of other arctic voyages) were noted: indeed, the mildness, arctically speaking, of the temperatures experienced, is somewhat remarkable. The auroras do not seem to have been sufficiently brilliant to call for especial comment. The ice reached about six feet in thickness, and all parts of it contained more or less salt; while the precipitation of snow was insufficient to afford a supply of drinking-water by melting. On this account, water had to be distilled most of the time, — a process which used much invaluable fuel. Many of their experiences were such as had already been recorded by those who drifted with the Germania's crew, the Tegethoff, or the floating Polaris' party, of which the indefatigable Nindeman had been a member. Payer's conclusion that the motions of the arctic pack result from the friction upon its surface of the prevailing winds, was fully confirmed, and placed upon an impregnable basis, by the drift of the Jeannette. This is perhaps the most important generalization the history of the voyage affords. Another fact of value is the determination of the shallow character of this part of the arctic basin, which nowhere reached one hundred fathoms in depth, and was usually less than fifty fathoms. From the constant though moderate motion of the pack which held



JEANNETTE ISLAND (FROM A SKETCH BY MR. MELVILLE).

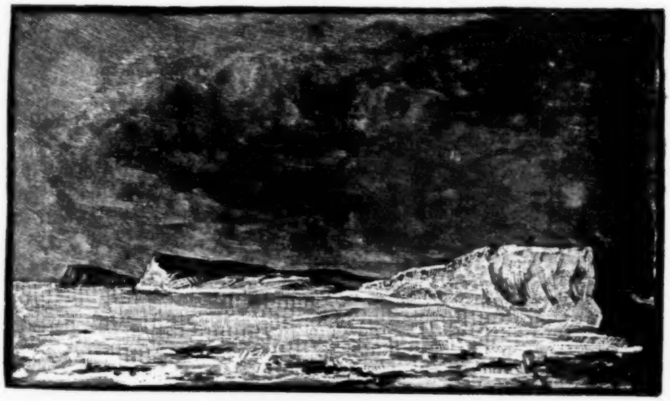
the vessel, tidal observations were impracticable; and the disturbances of the surface so occasioned, also prevented the permanent occupation of an observatory away from the ship. Polar bears, seals, a fox or two, walrus, and a small number of birds, comprise the air-breathing vertebrates obtained. Some fish-bones were found on the ice, but it does not appear that any fishing was attempted. Vignettes from the pencil of Mr. Newcomb, who acted as naturalist of the expedition, are scattered through the text, and illustrate the scanty fauna in a neat and artistic way. On the 16th of May, 1881, land was seen bearing nearly west, which was named Jeannette Island. It proved to be a small rocky island with bold shores, and was situated in latitude 76° 47′, and east longitude 158° 56′. On the 24th another island was observed more to the north and west, which



A POLAR BEAR.

was named Henrietta Island. This was visited by Melville, with a small party, ten days later. After great difficulties, caused by the hummocky ice, they succeeded in landing upon it, and found it to be a desolate rock, surmounted by a snow-cap which discharged in several glaciers on the east side. Dovekies nesting on the face of the rock were the only sign of life about it other than a little stunted vegetation. But a great change was at hand. Motions and fractures of the ice increased; and the ship was evidently in serious danger, which was accordingly provided for. On June 12, 1881, the Jeannette yielded to the irresistible pressure, and at four o'clock the next morning she sank. The retreat was then organized and begun, with several men on the sick-list in addition to the usual difficulties offered by rough, broken, and fissured ice. After a little, De Long made the painful discovery that the ice was drifting northward faster than they were able to travel in a southerly direction. The course was therefore altered to cross the drift in a south-westerly direction, in the hope of escaping from the moving area. About the middle of July more land was observed, and on the 28th the party succeeded in landing upon it after almost incredible exertions. This land, the loom of which had been reported by Russian explorers on the New Siberian Islands many years ago, but which had never been definitely verified or charted, was named Bennett Island; and we observe that in the map accompanying the work, this and the others are very appropriately included under the name of the De Long Islands. Coal, hematite, fossiliferous limestone, clay, and lavas were observed on this island, and, more important for the party, myriads of sea-fowl breeding in the rocky cliffs. There were several glaciers, and, to one hundred feet above the sea, masses of driftwood embedded in the soil, indicating tolerably recent elevation of the land. Hence by way of the New Siberian Islands, touching at Thaddeieff, Kotelnoi, Semeonoffski, the party made their way, but became separated in a gale of wind on the 12th of September, after which the smallest boat, with its crew, was never heard from; and finally the two remaining boats reached the shores of the Lena delta. De Long landed on the north Sept. 17, and Melville the previous day reached the south-eastern angle, and entered a branch of the river. It is not necessary to recapitulate the circumstances which attended the retreat, — the heroic journey of Nindeman and Noros, the indefatigable search of Melville, the final recovery of the remains, and their temporary interment on Monument Hill, looking out upon the flat stretches

BENNETT ISLAND AS SEEN IN THE DISTANCE, JULY 19.



MONUMENT HILL, JENA DELTA.

of the delta. These facts are the property of the public, which has not failed to appreciate the heroic qualities exhibited, nor to observe that the disastrous result of this unfortunate expedition offers in great part its own explanation. If it teach the aspiring that mere uninstructed courage cannot take the place of science, De Long and his people will not have died in vain. That this lesson should be especially emphasized, from recent events in another part of the arctic regions, will occur to most of our readers. Perhaps it would be well to permit future candidates for such work to convince themselves by trial, that the most exalted bravery will not enable the inexperienced to milk a fractious cow; and that, if so simple a matter requires knowledge and experience, it may be well to hesitate before assuming the fearful responsibility of hazarding the lives of even willing subordinates, without reasonable preparation for the problems offered by all serious arctic work, whether of exploration or retreat. Tenderness toward the dead should not be for an instant permitted to befog this self-evident truth, the statement of which is a duty owed, not merely to those who may hereafter attempt arctic exploration, but on behalf of scientific training everywhere.

## STEP'S PLANT-LIFE.

*Plant-life: popular papers on the phenomena of botany.* By Edward Step. With 148 illustrations drawn by the author, and engraved by W. M. R. Quick. New York, *Holt & Co.*, 1883. 12+218 p. 12°.

Year by year there is what may be termed a noticeable amelioration in the character of the botanical literature which appears in this country. By this we mean no discourtesy to the authors of the many excellent works which have appeared from time to time. In certain scientific lines, the botanical literature of the United States has been both voluminous and of a high order of excellence. In systematic botany, the publications of Torrey, Gray, Eaton, and Watson (to mention only a few of the later workers) have not been excelled anywhere. We may justly feel a national pride in such magnificent books as the two volumes of the Botany of California, the Botany of the Clarence King reports and of the Wheeler reports, the Ferns of North America, etc. Then, too, our school and college books have been worthy of their authors. What country was ever supplied with better field-manuals than Gray's or Wood's? and where can one find as good a treatise on the morphology of the phanerogams as Dr. Gray has given us in the latest edition of his Structural botany?

All these, however, are for students and botanists proper. They were not designed for the general reader, — the man who does not take botany in such dreadful earnest as do the botanists, but who asks of the gentle science that it shall please and amuse him. Our scientific botanists have been too busy with the serious matter of instructing their classes of young people in school and college, to turn aside and furnish entertaining reading for the unbotanical. We can scarcely blame them for thus neglecting the great outside world, when the small world of the classroom required all their time and strength; and yet we cannot help feeling that it would have been better for the botanists, as well as for botany itself, had they compelled themselves to find time for those lighter works which have, in other countries, been at once the recreation of the scientific man and the pleasure of the general reader.

In the work before us we have an example of what may be done in the way of putting the main facts of biological botany before the unbotanical in plain and easy English, and in such a way as to be attractive and interesting. We wish its English author were an American; but, that being an impossibility, it is most gratifying that the Messrs. Holt have brought out so neat an American edition.

It is, of course, to be expected that there is nothing new botanically in such a book; so that those who are fairly well equipped with a knowledge of recent botanical literature need not take it up in the hope of gleaning any new facts. It is only what its titlepage indicates, — an aggregation of popular papers on some of the phenomena of botany. They are not profound, nor are they so arranged as to present themselves as a series of connected lessons. They are rather like lightly drawn sketches, — now of this interesting view of a portion of the plant-world, and now of that. Thus we have a chapter on microscopic plants, another on plant structure and growth, one on the fertilization of flowers, followed by others on predatory plants, remarkable flowers and leaves, and about a fern. Then we have the folk-lore of plants, plants and animals, mosses and lichens, etc. So the chapters (fourteen in all) run on through the book, there being a delightful alternation of the structural with those which deal with sentimental or poetical considerations.

Considering the nature of the book, the errors are remarkably few. Here and there,

however, are statements which ought to be changed in a second edition. The Zygnemae are erroneously described as producing zoospores (p. 5), — a statement true enough of their relatives the Confervae, but not of any of the Zygnemae. Of roots it is said positively (in italics, p. 29) that 'they are never green,' which, to say the least, is a strong statement. On p. 34 we find that "in some plants the calyx or corolla is entirely wanting, in which case the floral covering is called the *perianth*," which is certainly not in accordance with ordinary usage. On the same page the stigma is curiously described as 'the surface of the style.' The Equiseta are not leafless, as they are said to be on p. 164. Their leaves are small, it is true; but certainly the whorls of united leaves at each joint are evident enough to even the casual observer. The formation of the zygospore in Mucor is not correctly given on p. 184, where it is described as resulting from the union of two aerial hyphae. On p. 192, in describing the fly fungus, the reader is given the impression that a mycelium upon a surface (as a window-pane) attacks its hapless victim, the fly, which, when dead, is said to be "standing upon a mat of delicate silk threads spread upon the glass."

Fig. 21 (repeated in fig. 143) is erroneous in showing the hyphae of the potato fungus to be septated. Fig. 104 is said to show the antheridia of a moss; but certainly no such organs are visible in the cut given.

In spite of the slips noted above, and others which we may well pass over, the little book is a pleasant one to read, and we feel sure that it will receive a hearty welcome from plant-lovers everywhere.

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# *WEEKLY SUMMARY OF THE PROGRESS OF SCIENCE.*

## ASTRONOMY.

**Saturn's rings.** — Encke's division in the outer ring of Saturn has been examined by M. Schiaparelli, who finds that the position and lack of symmetry are the same as previously noticed, but the line is broader, and more diffused than in 1881. He thinks the phenomenon is variable, and accounts for it by supposing the middle of the ring to be thinner, and by the change of orbit of the particles composing it. He also examined carefully the region about the inner bright ring and the dark ring. At times O. Struve's division was seen very distinctly, and on other occasions very faintly. More observations are necessary to determine whether the phenomenon is variable. — (*Observ.*, Aug.; *Astr. nachr.*, 2,521.) M. McN. [289

**The great comet of 1882.** — Mr. Maxwell Hall shows the possible identity of the great comet of 1882, the comets of 1880, 1843, and 1668, with a comet which appeared B.C. 370, and which was said to have separated into two parts. The orbits of all are nearly identical. Taking a period not greatly different from that given by Prof. Frisby for the comet of 1882, he identifies the comets of B.C. 370 and A.D. 1843 with one which was seen in 1106. No comet is recorded for A.D. 368. The comets of 1880 and 1882 may possibly be identical with two which appeared in 1131 and 1132, and with the second part of the comet of B.C. 370. If this is the case, this comet also probably separated into two parts at its unrecorded appearance in A.D. 381 or 382. We already have an instance of this separation in Biela's comet; and the comet of 1882 gave evidence, to a certain extent, that a process of disintegration was going on. — (*Observ.*, Aug.) M. McN. [290

## PHYSICS.

### Electricity.

**Atmospheric electricity.** — Dr. L. J. Blake has found that no convection of electricity takes place by the rising vapor from a charged liquid surface, to which he gave a potential due to from four to five hundred Daniells cells. The plate placed in the track of the vapors was, in the different experiments, either colder than the vapor, or of the same temperature. By connecting the liquid with the electrometer, he finds a small negative charge, increasing during the fifteen minutes which each experiment lasted, but not sufficiently to justify the statement that electricity is generated by evaporation. In all the work, the lamp was removed before connecting with the electrometer; and the whole apparatus was within a metallic covering connected with the earth. Distilled water, sea-water from the North Sea, alcohol, dilute sulphuric acid, mercury, and solutions of a number of different salts, were tried. — (*Ann. phys. chem.*, xix. 518.) [291

## ENGINEERING.

**A new current-meter.** — Mr. L. d'Auria proposes an apparatus for determining the mean velocity at any vertical in a stream, which apparatus consists of a scow, or pontoon, to be moored in the desired place; a pole with a pulley near each end, carrying an endless cord; a light ball; and a species of net, or grillage. The pole is thrust to the bottom alongside the scow, at the point where the velocity is to be gauged; and the ball is lightly attached to the cord by a string, so as to be disengaged by a moderate pull when it reaches the pulley at the bottom. The time of the disengaging pull is noted, and also the time of the appearance of the ball at the surface. As the

floating grillage has previously been moored over this place, the ball is caught at the point of rising, and the horizontal distance of this point from the pole measured. Hence are known, upon measuring the depth, the two co-ordinates of the point at the surface from the bottom of the pole. The author proposes to weight the ball until it shall be one-half the heaviness of water. He deduces some equations to prove that the ball rises with a practically uniform velocity, and observes, that for a depth of 30 feet, from which such a ball would rise in about 11 seconds, and a mean velocity of current of 4 feet per second, the ball would travel horizontally about 44 feet.—(*Amer. eng.*, Aug. 24.) C. E. G. [292

### CHEMISTRY.

(*Physical.*)

**Determination of vapor density.**—Br. Pawlewsky proposes a modification of Dumas' method in which he uses a globe of 20–30 cubic centimetres volume. After heating, the globe is closed by a rubber cap, which is fitted to a cylindrical tube of glass sealed at one end. The volume is therefore constant for different determinations, and the observations may be taken in a room of nearly constant temperature. In the formula of Dumas,—

$$m = \frac{0.0012932 \,.\, V \,.\, B_0}{(1 + \alpha t)\,760}, \qquad \text{(I.)}$$

where $m$ is equal to the weight of air, the product $0.0012932 \,.\, V = K$ would be constant. The value $(1 + \alpha t) = N$ is constant, and may be obtained from a table. If, then, the constant, $K$, is divided by 760, a new constant, $D$, results, and (I.) becomes

$$m = \frac{K \,.\, B_0}{N \,.\, 760} = \frac{D \,.\, B_0}{N}. \qquad \text{(II.)}$$

In a determination at any temperature, $t'_0$, and any pressure, $B'_0$, if the weight of air in the apparatus is represented by $n$, its weight is shown in the formula

$$n = \frac{0.0012932\ V\ (1 + \kappa t')\ B'_0}{(1 + \alpha t)\ 760}, \qquad \text{(III.)}$$

in which $\kappa$ represents the coefficient of expansion of the apparatus. If the temperature is constant, and the same apparatus is used in different determinations, the product $0.0012932\ V\ (1 + \kappa t')$, and the whole denominator, become constant. Representing the denominator by $R$, and the product $0.0012932\ V\ (1 + \kappa t')$ by $M$, the fraction $\frac{M}{R} = C$ is constant, and formula (III.) will take the form

$$n = \frac{M B'_0}{R} = C \,.\, B'_0. \qquad \text{(IV.)}$$

The volume of air may therefore be obtained by multiplying the constant, $C$, by $B'$ reduced to $B'_0$; and when the weight, $a$, of the vapor, and that of the air, $n$, under the same conditions, are known, the vapor density may be found by the formula

$$D = \frac{a}{n}. \qquad \text{(V.)}$$

The apparatus may be heated in a beaker of medium size, containing water, oil, or paraffine. For a complete description of the apparatus, reference must be made to the original article. A series of determinations are given, which indicate a high degree of accuracy.—(*Berichte deutsch. chem. gesellsch.*, xvi. 1293.) C. F. M. [293

### GEOLOGY.

**Evidences of modern geological changes in Alaska.**—Mr. T. Meehan exhibited a piece of wood taken from a prostrate tree which had been covered with glacial drift on a peninsula of Hood's Bay, Alaska, formed by the junction of Glacier Bay and Lynn Channel. The trunk, which lay under a block of granite estimated to measure 2,214 cubic feet, was quite sound, and exhibited no evidence of great age since it became covered. The shores are strewn with rocks and stones of various kinds, as usual in cases of glacial deposits. All the surroundings indicated that there had been a sudden subsidence of the land, accompanied by a flow of water with icebergs and huge bowlders, which crushed and tore off the trees. The whole surface was afterwards covered to a great depth with drift. Since that time, there must have been an elevation of the land bringing the remains of trees to their original surface, but with a deep deposit above them. A study of the existing vegetation might afford an approximation to the time when these events occurred. The living forest indicated clearly that it could not have been, at the farthest, more than a few hundred years since the elevation occurred. The trees in the immediate vicinity, indeed, were not more than fifty years old; but unless the original parent trees, which furnished the seed for the uplifted land, were near by, it might take some years for the seed to scatter from bearing trees, grow to maturity, again seed, and, in this way, be spread to where we now find them. But, as original forests were evidently not far distant, two or three hundred years ought to cover all the time required. The Indians of the region have a tradition of a terrible flood about seven or eight generations ago, from which only a few of the natives had escaped in a large canoe. The probable identity of the sunken trees with the present species, and the freshness of the wood, indicate no very great date backwards at which the original subsidence occurred.

In connection with the subject of the comparatively recent occurrence of great geological changes, as indicated by botanical evidence, Mr. Meehan referred to an exposure of the remains of a large forest near the Muir glacier,—one of five huge ice-fields which form the head of Glacier Bay between Lat. 59° and 60°. This glacier is at least two miles wide at the mouth, and has an average depth of ice, at this spot, of perhaps five hundred feet. At the present time there is not a vestige of arboreal vegetation to be seen in the neighborhood. The river which flows under the glacier rushes out in a mighty torrent a few miles above the mouth, and has cut its way through mountains of drift, the gorge being many hundred feet in width, and the sides from two hundred to five hundred feet high. The torrent, though the bed is now comparatively level, carries with it an immense quantity of heavy stones, some of which must

have contained six or eight cubic feet. Along the sides of this gorge were the exposed trunks referred to, all standing perfectly erect, and cut off at about the same level. Some were but a few feet high, and others as much as fifteen, the difference arising from the slope of the ground on which the trees grew. The trunks were of mature trees in the main, and were evidently Abies Sitkensis, with a few of either Thuja gigantea or Juniperus, perhaps J. occidentalis. These trees must have been filled in tightly by drift to a height of fifteen feet before being cut off: otherwise the trunks now standing would have been split down on the side opposite to that which received the blow. The facts seemed to indicate that the many feet of drift which had buried part of the trees in the first instance were the work of a single season, and that the subsequent total destruction of every vestige of these great forests was the work of another one, soon following. As in the case of the facts noted in Hood's Bay, the conclusion was justified, that the total destruction of the forests, the covering of their site by hundreds of feet of drift, and the subsequent exposal of their remains, were all the work of a few hundred years. — (*Acad. nat. sc. Philad.; meeting* Aug. 28.) [294

## MINERALOGY.

**Stibnite from Japan.** — Within the last few months most remarkable specimens of stibnite from Mount Kosang, in southern Japan, have been received in America. For great size and beauty, as well as complexity of form, they rival all specimens of the same species from other localities, while the crystals have arrived at a degree of perfection rarely met with in metallic minerals. The crystals have been carefully studied and fully described by E. S. Dana. Their great complexity of form is of the highest scientific interest. There had previously been identified on stibnite forty-five crystal planes. Of these, thirty have been observed on the Japanese crystals, and, in addition, forty new ones. The habit of the crystals is quite constant, being prismatic, elongated in the direction of the vertical axis, single crystals obtaining often a length of over twenty inches and a width of two inches. The prismatic planes are deeply striated. The crystals are usually terminated by a few polished pyramidal faces. They are usually quite simple in form; very complicated, large crystals occurring only occasionally, while the more complicated ones are usually small. The planes in the zone between the brachypinacoid (010) and unit macrodome (101) are those which ordinarily terminate the crystal. Another remarkable zone is between the brachypinacoid (010) and macrodome (203), consisting of ten planes, all but one of which are new, and as many as nine of which have been observed on a single crystal. A bending in the direction of the macrodiagonal axis is a feature of the crystals, and seems to be characteristic of the species. In the Japanese crystals this bending seems to be confined to the termination. A corkscrew-like twist has been observed in slender crystals. The lustre of the crystals is very remarkable, and is to be compared to highly polished steel, while the perfect brachypinacoidal cleavage yields a cleavage-surface of remarkable beauty. — (*Amer. journ. sc.*, Sept., 1883.) S. L. P. [295

## GEOGRAPHY.

*(Asia.)*

**Railways in the Caspian region.** — General Chernaieff, the governor of Turkestan, has recently gone over the route from Kungrad to the Caspian in person, and finds it well suited for vehicles. Even a railway between the delta of the Oxus and the Gulf Mertvi-kuttuk has been talked of. The connection of Tiflis and Baku by rail is completed, and the journey can now be made between the Black and Caspian seas in thirty hours without change. — (*Comptes rendus soc. géogr.*, June.) W. H. D. [296

**Prjevalski's travels.** — This indefatigable explorer has just started for Kiachta, on the Siberian border of China, in order to continue his researches in central Asia. On this occasion he will endeavor to penetrate the north-west part of Thibet, without giving up his original idea of reaching Lassa, or at least as far as Batang or Tziamdo. He will have a well-armed escort of some twenty men, fully equipped for two years' service. The publication of the third volume of his travels has just been finished. During these he has travelled 23,530 kilometres; topographically sketched over 12,000 kilometres along his line of travel, in countries previously quite unknown; determined the altitude of 212 points, and the latitude of 48 localities; and has collected ten or twelve thousand specimens of animals and plants belonging to over two thousand species. — (*Comptes rendus soc. géogr.*, June.) W. H. D. [297

*(Africa.)*

**Notes.** — C. Doelter has ascended the Rio Grande as far as Futa Djallun, but was prevented from going farther east by a war among the natives. He believes that the Rio Grande has been incorrectly mapped, and doubts its alleged identity with the Tomani River. —— The English have annexed the Guinea coast from the right bank of the Mannah River toward the Liberian boundary-line, — a distance of eight leagues in a north-westerly direction; and the Portuguese government has ceded to England the fort of St. John de Ajuda, situated on the Dahomey coast. Ajuda, or Whydah, is situated a short distance from the coast, on a shallow lagoon. The port is a poor one, like all those on the Guinea coast; and there are very few white residents. It is said that the cession was contingent on the recognition, by England, of the acquired rights of Portugal on the Congo. —— Robert Flegel, during the past season, has discovered the source of the Binué, an affluent from the east of the lower Niger, and also of the Logué, which discharges into Lake Chad. In this way he has been able to trace the watershed between the two basins, through a previously unexplored district. —— Hore has arrived at Ujiji on Lake Tanganyika, and proposes to establish a regular postal service on the lake, between the missionary and other stations. —— Dr. Baxter has attempted an exploration of the country of the Massai adjacent to Mpuapua.

These people are extremely hostile to strangers, and his success, therefore, is problematical. —— The Mahdi, or false prophet, who has been menacing Khartum, is reported to have captured the traveller, G. Roth, who was sent out by the Geographical society of St. Gall, Switzerland, to explore the upper Nile. —— Yunker has succeeded in passing from the basin of the Nile to that of the Congo, and continues his explorations, while one of his party has returned with the collections made in the Niam-Niam country. —— Paul Soleillet writes from Ankober of his safe arrival at Shoa, the success of his journey, and his favorable reception by King Menelik II., who governs all the population of Obok Shaffa and adjacent region with a firm rule. Menelik is favorable to trade with foreigners; and it is announced that he has been named by King John of Abyssinia as his successor, in default of direct heirs, to that kingdom. Soleillet has formed valuable collections, and has discovered wild coffee forming a dense undergrowth in the forest along the river Guébé, and indefinitely beyond. He reports the product of the wild plant to be of excellent quality. —— The abbé Trihidez, almoner of the army of occupation in Tunis, is reported to have discovered at Susa some Phoenician stelae engraved in a rather artistic manner, and in a good state of preservation. These records have been pronounced to be of great interest by such eminent specialists as Renan and Berger. —— M. Alphonse Aubry has forwarded to the Ministry of public instruction at Paris, reports on the geology of the English colony of Aden, which is situated in the horseshoe-shaped crater of an extinct volcano, and on the French colony of Obok on the opposite shore of the Gulf of Aden. —— Gold has been found on the Kaap River in the Transvaal. Nuggets of half a pound in weight are reported. —— Oil has been 'struck' in Natal, near Dundee, and also large deposits of magnetic iron. A company has been formed at Pietermaritzberg to investigate these minerals. — W. H. D. [298

## BOTANY.

**Thermotropism.** — Julius Wortmann has recently shown that radiant heat falling upon a growing organ can cause curvatures either toward or away from the source of energy, and that the phenomena are in general much like those produced by light. His experiments are interesting, but are, as yet, incomplete, leaving some questions which seem to us very important wholly unanswered. It is pretty clear, however, that hereafter we must add the words 'positive thermotropism' and 'negative thermotropism' to the already long list of new terms. — (*Bot. zeit.*, 1883, no. 29.) G. L. G. [299

**On the growth of the epicotyl of Phaseolus multiflorus.** — In a series of experiments published in 1878, Wiesner detected two maxima of growth characterizing the younger internodes of many plants, whereas Sachs (and more lately Wortmann) had recognized only one maximum. To satisfy himself of the correctness of his former observations, Wiesner has repeated and extended the experiments. His results, derived from more than one hundred cases, show that in the plant named there are two distinct maxima of growth. The measurements were made with Grisebach's auxanometer. — (*Bot. zeit.*, 1883, no. 27.) G. L. G. [300

## VERTEBRATES.

### Reptiles.

**Organ of Jacobson in Ophidia.** — Born regarded the cellular columns which form the greater part of the thickness of the roof of Jacobson's organ as "*die zellige ausfüllungsmasse einfacher drüsen von birnförmiger configuration. Sie dicht an einander gedrängt die ganze schleimhaut durchsetzen,*" while Leydig believed them to be largely of ganglionic nature. E. Ramsay Wright agrees with Leydig. He has studied the organ in Eutaenia (embryo and adult). In conclusion, he says, "From the above data I conclude that the cellular columns in the roof of Jacobson's organ are outgrowths of the nuclear stratum of its neuro-epithelium, the polygonal form of which has been determined by the meshes of the capillary plexus, through which the outgrowths have taken place, and that in the course of development more and more of the cells of the nuclear stratum have been pushed outside the boundary formed by the capillary plexus, till eventually little but the superficial stratum is left inside that boundary." — (*Zool. anz.*, vi. 389.) C. S. M. [301

### Mammals.

**The species of hogs.** — M. Forsyth Major is convinced, from his study of the genus Sus, that the sixteen or seventeen species now recognized must be reduced to four; namely, Sus vittatus Müll. and Schleg., S. verrucosus M. and S., S. barbatus M. and S., and S. scrofa Linné. — (*Zool. anz.*, vi. (140), 1883, 295.) F. W. T. [302

**Digestion of meats and milk.** — Jessen has carried out a series of experiments to determine the time necessary for the digestion of equal quantities of different meats and of milk. Three different methods were employed in the investigation: 1. Artificial digestion; 2. Introduction of the meats into the stomach of a living dog by means of a fistula; 3. Upon a healthy man, allowing him to swallow the foods used, and ascertaining the time of digestion by means of the stomach-pump. The results obtained by the different methods are, on the whole, uniform, as far as the relative time necessary for digestion in each case is concerned, and may be stated as follows: raw beef and mutton are digested most quickly; for half-boiled beef and raw veal, a longer time is necessary; thoroughly boiled and half-roasted beef, raw pork, and sour cow's-milk follow next; fresh cow's milk, skimmed milk, and goat's milk are still less easily digested; while the longest time is required for thoroughly roasted meats and boiled milk. — (*Zeitsch. f. biol.*, xix. 129.) W. H. H. [303

## ANTHROPOLOGY.

**Iron in the mounds.** — F. W. Putnam has had occasion to review some of the statements of the older writers on American archeology, — notably, Mr.

Atwater and Dr. Hildreth, — with reference to the occurrence of iron implements in the mounds. From these statements, such inferences as the following have been drawn: —

The mound-builders understood working iron; they had intercourse with civilized peoples; the mounds were built since the arrival of the whites, or these iron objects belong to intrusive burials. Now, Mr. Putnam demolishes all these deductions at a single blow, by showing that none of the objects are iron. In other words, Mr. Atwater's "handle of either a small sword or a large knife" was an antler, in one end of which a hole had been bored, and around this part was a band of silver. The blade was evidently of native, cold-hammered copper. Dr. Hildreth's silver-plated ear-ornament is duplicated in some of our museums by a kind of plating, first described by Mr. Putnam. In this discussion, some light is thrown upon the spool-shaped copper objects that have been so long a puzzle to archeologists, by the finding of pieces of 'leather' between the plates, very closely resembling the skin from the ear of a Peruvian mummy. Important discoveries made during the last year, in mounds in Ohio, by Dr. C. L. Metz and Mr. Putnam, have brought to light a number of copper ornaments, some of which are covered, or plated, with thin layers of silver. The investigation shows us quite conclusively that we are no longer safe in our archeological deductions, except in the hands of a skilful guide. — (*Proc. Amer. antiq. soc.*, ii. 349.) O. T. M. [304

**Aztec music.** — Mr. H. T. Cresson has been studying the musical instruments of the ancient Mexicans. The *huehuetl*, or large drum of the great temple, at the ancient pueblo of Tenochtitlan, was covered with the skins of serpents, and when beaten could be heard at a distance of several miles. Clay balls were placed inside of their grotesque clay images, also within the handles attached to their earthenware vessels, which are generally hollow. Some of these rattles in the Poinsett collection resemble the head of Crotalus horridus, and give forth a rattling sound. In this connection Mr. Cresson makes a very suggestive observation which we do not remember to have seen before: "It may therefore be supposed that these children of nature noticed and strove to reproduce sounds, which, however harsh and unmusical to us, to them were pleasing, because they recalled familiar objects." The author thinks he can recognize the Mexican Hyladae, macaws, parrots, and other bird-calls. A musical vase is spoken of. Mr. Barber's assertion that the fourth and seventh are wanting from the diatonic scale is denied, since, in the Poinsett collection, there exist Aztec flageolets capable of producing not only the fourth and seventh of the diatonic scale, but also the entire chromatic scale. This subject is elaborated at great length. Mr. Cresson thinks that the musicians of our day have arrived at a somewhat hasty decision in regard to the music of these ancient people, and its confinement within the narrow limits of a pentatonic scale. — (*Proc. acad. nat. sc. Philad.*, 86.) J. W. P. [305

## NOTES AND NEWS.

THE resolution of the American association, offering all the privileges of membership for next year's meeting to the members of the British association, was received by the latter with much enthusiasm; and the council of the British association, with which such matters lie, will, it is said, extend a similar invitation to the American association. The Canadian authorities have arranged for such members of the British association as may desire, to take the longer excursions planned for them *before* their meeting on Aug. 27, and thus allow them to attend the meeting of the American association in Philadelphia, Sept. 3, without losing their excursions. It is hoped that at least five hundred members of the British association, including many leading scientific men, will attend the Montreal meeting; while there seems to be a very general wish, more especially on the part of the younger scientific men, to attend the Philadelphia meeting as well.

— The following is the list of grants of money, which, according to *Nature*, the British association has granted for scientific purposes for the coming year; amounting, in all, to seven thousand dollars. When may we hope for even the beginning of such a list from the American association, with its two thousand members?

*A. — Mathematics and physics.*

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| Brown, Prof. Crum, Meteorological observations on Ben Nevis | £50 |
| Foster, Prof. G. Carey, Electrical standards | 50 |
| Schuster, Prof., Meteoric dust | 20 |
| Abney, Capt., Standard of white light | 20 |
| Scott, Mr. R. H., Synoptic charts of the Indian Ocean | 50 |
| Stewart, Prof. Balfour, Meteorological observatory near Chepstow | 25 |
| Shoolbred, Mr. J. N., Reduction of tidal observations | 10 |
| Darwin, Prof. G. H., Harmonic analysis of tidal observations | 45 |

*B. — Chemistry.*

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| Odling, Prof., Photographing the ultra-violet spark spectra | 10 |

*C. — Geology.*

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| Etheridge, Mr. R., Earthquake phenomena of Japan | 75 |
| Williamson, Prof. W. C., Fossil plants of Halifax | 15 |
| Sorby, Dr. H. C., British fossil polyzoa | 10 |
| Prestwich, Prof., Erratic blocks | 10 |
| Etheridge, Mr. R., Fossil Phyllopoda of the paleozoic rocks | 15 |
| Hull, Prof. E., Circulation of underground waters | 15 |
| Evans, Dr. J., Geological record | 15 |
| Green, Prof. A. H., Raygill fissure | 15 |
| Prestwich, Prof., International geological map of Europe | 20 |

*D. — Biology.*

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| Newton, Prof., Zoölogical bibliography | £50 |
| Sclater, P. L., Natural history of Timor Laut | 50 |
| Lankester, Prof. Ray, Table at the zoölogical station at Naples | 80 |
| Harrison, J. Park, Facial characteristics of races in the British Isles | 10 |
| Hooker, Sir J., Exploring Kilimandjaro and the adjoining mountains of equatorial Africa | 500 |
| Cordeaux, Mr. J., Migration of birds | 20 |
| Foster, Dr. M., Coagulation of the blood | 50 |
| Stainton, Mr. H. T., Record of zoölogical literature | 100 |

*E. — Geography.*

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| Godwin-Austen, Lieut.-Col., Exploration of New Guinea | 100 |

*F. — Economic Science and Statistics.*

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| Brabrook, Mr. E. W., Preparation of the final report of the anthropometric committee | 10 |

*G. — Mechanics.*

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|---|---|
| Bramwell, Sir F., Patent legislation | 5 |

— Lieut. Ray returned to San Francisco, Oct. 7, by the schooner Leo. He left that port on July 18, 1881, under instructions from the signal-service bureau to establish a permanent signal-station at Point Barrow, and to remain there until the summer of 1884, unless otherwise ordered. The order for the party to return created great surprise, as the work was successfully carried on. Lieut. Ray stated, that, apart from the scientific importance of the station, it was a necessity, as a refuge for the crews of whaling-vessels. Every year, in the Arctic Ocean, there are, on an average, forty vessels, worth, with their cargoes, four million dollars, and employing sixteen hundred men. Out of eighty-seven vessels, fifty have been lost within a hundred miles of Point Barrow, in one year alone. In 1877 twelve were lost, with all on board. The crews would not abandon their vessels, knowing there was nothing on the shore. Had the station then existed, it is probable that all their lives would have been saved. Since the station was established, two years ago, over fifty lives have been saved. Lieut. Ray states, that all the party lived comfortably, and enjoyed good health, the climate being particularly beneficial to those suffering from malaria. Besides their regular provisions, the party had seal, walrus, and white whale meat; the last being the best, as it was sweeter and more nutritious. Lieut. Ray expressed regret at his recall.

— Lieut. Schwatka, who, with his party, was picked up by Lieut. Ray at St. Michael's, speaking of his trip up the Yukon River, Alaska, says they started from Fort Vancouver, W.T., on May 21, and travelled twenty-eight hundred miles overland, reaching the head waters of the river, where they constructed a raft of logs to navigate the stream to its mouth. They procured a crew of six Indians, and proceeded down the gradually increasing stream within two hundred and fifty miles of Fort Chilcat, where rapids were encountered. Down these the Indians refused to go, and attempted to force the raft ashore. Schwatka succeeded in suppressing the mutiny, and the rapids were run. The voyage on the raft was eighteen hundred and twenty-nine miles. From the mouth of the Yukon they proceeded to St. Michael's, where they boarded the Leo for this port. Signal-service officer Leavitt, who has been stationed at St. Michael's, and who also came down on the Leo, says he has ascended the Yukon to Fort Selkirk two thousand miles from its mouth. He describes the river as being one of the largest in the world, discharging fifty per cent more water than the Mississippi, and as being in places seven miles in breadth.

— Professor Oswald Heer, of the university and federal polytechnic school of Zurich, the celebrated Swiss paleontologist, died at Lausanne, Canton de Vaud, the 27th of September. Heer has done more for fossil botany and fossil insects than any one else during the last forty years, and his death will leave a place in science which it will be difficult to fill.

## RECENT BOOKS AND PAMPHLETS.

**Bernheim**, G. Incombustibilisation des théâtres et bâtiments. Nice, *impr. Gauthier*, 1883. 16 p. 4°.

**Berthelot**, M. P. E. Explosive materials: series of lectures delivered before the Collège de France, Paris; to which is added a short historical sketch of gunpowder. Translated from the German of Karl Braun by J. P. Wisser, and a bibliography of works on explosives. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 70.) 24°.

**Bourassé**, J. J. Histoire naturelle des oiseaux, des reptiles et des poissons. Tours, *Mame*, 1883. (Bibl. jeun. chrét.) 288 p., illustr. 12°.

**Briggs**, R. Steam-heating: an exposition of the American practice of warming buildings by steam. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 68.) 108 p., illustr. 24°.

**Brooks**, W. K. The law of heredity: a study of the cause of variation and the origin of living organisms. Baltimore, *Murphy*, 1883. 2+336 p., 2 pl., illustr. 16°.

**Browne**, W. R. The student's mechanics: an introduction to the study of force and motion. London, *Griffin*, 1883. 16+210 p., illustr. 16°.

**Campagne**, E. Les mines, or, argent, fer, cuivre, plomb, étain, zinc, mercure, et platine. Rouen, *Megard*, 1883. (Bibl. mor. jeun.) 190 p., illustr. 8°.

**Carrière**, E. A. Étude générale du genre pommier, et particulièrement des pommiers microcarpes ou pommiers d'ornement, pommiers à fleurs doubles, etc. Mesnie, *impr. Firmin-Didot*, 1883. 179 p. 18°.

**Foye**, J. C. Chemical problems, with brief statements of the principles involved. New York, *Van Nostrand*, 1883. (Van Nostrand's sc. ser., no. 69.) 24°.

**Freeman**, E. A. English towns and districts: a series of addresses and sketches. London, *Macmillan*, 1883. 13+455 p., 11 pl., map. 8°.

**Gladstone**, J. H., and **Tribe**, A. The chemistry of the secondary batteries of Planté and Faure. London, *Macmillan*, 1883. (Nature series.) 11+59 p. 8°.

**Gomme**, G. L. Folk-lore relics of early village life. London, *Stock*, 1883. 8+246 p. f°.

**Grant**, B. A few notes on St. Helena, and descriptive guide. To which are added some remarks on the island as a health resort, Capt. J. R. Oliver's geology of the island, and numerous appendices. St. Helena, *Grant*, 1883. 127 p., 8 phot. pl. 8°.

**Haeckel**, E. The pedigree of man and other essays. Translated by E. B. Aveling. London, *Freethought publ. co.*, 1883. 15+352 p., illustr. 16°.

**Kiddle**, H. A text-book on physics, being a short and complete course, based upon the larger work of Ganot; for academies, high schools, etc. New York, *Wood*, 1883. 272 p., illustr. 8°.

**MacLeod**, J. Leiddraad bij het onderwijzen en aanleeren der dierkunde. Algemeene dierkunde. Gent, *Vuylsteke*, 1883. (Willems-fond, uitgave 104.) 4+151 p., 1 pl., illustr. 16°.